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Editorial:

"We are concerned with an agency whose soul is an unattainable ideal, and whose life is dependent upon creative, organic evolution, both ecological and bureaucratic."

With these words, Paul Schullery presented his thoughts on the up-dating of the Leopold Report to the National Parks and Conservation Association's Commission on Science and Resource Management Policy in the National Park System at the Commission's first meeting April 18, 1988, in Washington, D.C.

The paper, which will be carried in its entirety in a future issue of the George Wright Society's FORUM, is entitled "Feral Fish and Kayak Tracks: thoughts on the writing of a new Leopold Report." It was brought to our attention by Doug Houston, research scientist at Olympic NP, and it deals with the problems posed by a thousand specific questions arising from as many unique Park System situations.

Said Schullery (a former associate editor of *Country Journal*, free lance writer and consultant on NPS matters, and now a technical writer on natural resource topics at Yellowstone NP):

"National parks, like all natural areas, still have their vacancy signs out. They are in no sense ecologically finished, and thus pose certain problems for the creative manager... for example, the basin of Yellowstone Lake is tilting; in a few years the nesting islands of white pelicans may be submerged, drowning one of the great nesting sites in North America. Should we be hauling gravel out there, or celebrating the imponderable power of natural processes? As you prepare to consider questions like that, I would like to leave you with two thoughts about the original Leopold Report.

"First," Schullery said, "like most great and enduring documents, it dealt in main principles. It is still at its best in its generalizations and at its most dated when it addresses specific management issues in specific parks. Ever since the idea of writing a 'new' Leopold Report surfaced, I've thought of how important it is that the document deal in the grand scale..."

Schullery's second thought dealt with "the peculiar felicity of expression" (as John Adams phrased it) that marked Thomas Jefferson's Declaration of Independence - "that most enduring of all American documents, that masterpiece of balance and principle," and Schullery's hope that that quality from the original Leopold Report might endure in its re-writing.

And finally, Schullery urged the commission to exercise "the sensitivity that will come from some compromise between telling the Park Service what it should do in every situation - something nobody knows - and telling it so little that we leave it on its own.... We must strike a balance that gets both the best of the agency's powers and the collective wisdom of the agency's friends and watchdogs. Only in that way," Schullery concluded, "lies any hope of success."

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Cover: Peregrine falcon chick nestles in a friendly hand as National Park personnel join on its side in the battle for survival. Stories beginning on page 3.

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Distribution of Peregrine Falcon In Zion National Park

By Larry L. Hays and Timothy J. Tibbitts

The existence of peregrine falcons, *Falco peregrinus anatum*, in Zion NP has been documented as far back as the 1920s, when peregrines apparently were recognized as residents but were not regularly seen. C.C. Presnall's 1935 checklist, *The Birds of Zion National Park*, failed to list the bird. One of the earliest naturalists, Russell K. Grater, observed nesting activity in 1939; Dennis Carter and Roland Wauer identified peregrines in the park in 1963 and 1964, and other random sightings were reported over the years following.

In 1982, the authors saw peregrines in both the upper and lower canyon areas and determined these were two separate reproducing pairs. No eyrie was located for the lower canyon pair, which were not found until August. One male juvenile was present with the adults at both locations. In 1983 the upper canyon site was active but no peregrines were observed in the lower Zion canyon.

Zion NP is located on the western edge of the Colorado Plateau in Southern Utah. The park, covering 59,551.1 ha, is composed of deeply eroded canyons with high, timber-covered plateaus and mesas. Elevations range from 2,652 m in the northwest corner to 1,128 m in the southeast. Rainfall ranges from about 56 cm on the plateaus to 35 cm at lower elevations. Habitat for peregrines is excellent, with cliffs up to 762 m in height, framing riparian corridors with productive pinyon-juniper woodlands. Upper elevations contain oak brush, manzanita, and ponderosa pine.

Objectives of the study here described were to determine the number of nesting peregrines in Zion, their distribution, and their reproductive success. The roots of the formal study go back to 1984, when a survey was made in Zion by the Peregrine Fund under contract with NPS. Dr. James H. Enderson of Colorado College coordinated the survey. Four two-person teams looked for peregrines over a four-day period; 19 sites were selected by looking at habitat from a fixed wing overflight. Each team was placed by helicopter and remained approximately 24 hours. Two new territories were found and verified. All territories were monitored during the summer and six juveniles were fledged.

Second Survey Mounted

In 1985, the Peregrine Fund conducted a second survey. Again, four two-person teams were deployed over a four-day period. Territories found in 1984 were rechecked and new areas were surveyed. Two more new territories were found and the two from the previous year reconfirmed. The lower Zion canyon eyrie was not located, but juveniles appeared within the territory at the appropriate time. Active territories in 1985 now numbered six. All six were monitored throughout the summer and 11 juveniles were fledged.

In July 1985, Dr. Enderson returned to the park with a helicopter and climbing team to enter sites and gather prey remains and eggshell fragments. Zion's resource staff provided assistance in directing the climbers into the eyries. Seven eyries in four territories from 1984 and 1985 were entered and shell fragments and prey remains were removed. Eggshell measurements revealed a thinning problem of 21 percent – a thinning degree that did not support an optimistic prediction for

the future of Zion's falcon population.

In 1986 no funds were available to conduct helicopter surveys. The authors monitored all known territories and active eyries were located in all six territories occupied the previous year. Further habitat surveys stemmed from the observation that distances between known eyries were extremely uniform – suggesting a population of sufficient density for territorial interactions to be determining distribution.

To test this hypothesis, the average inter-eyrie distance was projected into unsurveyed habitat from nearest-neighbor eyries. The areas then were entered on foot; suitable cliffs at the "standard" distance were examined. On the first test, a female passage bird was observed loosely on the territory. The second test found an adult pair on territory. Flying young were present on the next visit to this site. The third test of the spacing hypothesis yielded another active eyrie, which later fledged young successfully.

Eyrie Count Increases

This brought the 1986 census to eight active eyries, with evidence of a floating subadult population in peripheral habitat. All eight territories were monitored throughout the summer; 14 juveniles were fledged.

Funds were available again in 1987 to provide for two people for a week in late May and a helicopter count of juveniles in June. The authors had entered and confirmed most of the eyries from previous years before the Peregrine Fund team arrived. Dr. Enderson again coordinated the operation.

Weather was bad – high winds and rain throughout the week. The spacing technique was used to place the team in areas that were unsurveyed. A new eyrie was confirmed the morning of the first day. Rain and snow at higher elevations precluded good examination of several excellent possibilities and the team was forced to leave the park without surveying some of the sites the park had hoped to evaluate.

Finding of the new eyrie brought the number of active eyries to nine. The new eyrie contained three juveniles. All nine eyries were monitored all summer. A helicopter flight in late June counted 22 juveniles. One site showed incubation behavior into mid-June, leading to the belief that the nesting attempt had failed. However, continued monitoring revealed the pair had recycled and eventually produced three young late in the season, bringing the reproductive success to 25 young in 9 eyries for a ratio of 2.77 juveniles fledged per eyrie.

This breeding season produced the first four-juvenile eyrie ever seen in Zion. The final tally showed one four-juvenile eyrie, five eyries with three juveniles each, and three eyries with two juveniles each. Reproductive success of this magnitude has not been seen before and with the eggshell thinning problems we are faced with the question "How is this level of reproduction possible?"

A Computer-based Product?

The "population explosion" of peregrines in Zion NP is almost certainly an artifact of data generation, reflecting an explosion of monitoring activity more than actual peregrine numbers. The increase from one known eyrie in 1982 to nine in 1987 parallels a period of increasingly intensive study of the species in the park.

The Zion population is significant in several aspects. Nine known eyries within the park confines represent one of the densest concentrations of breeding peregrine falcons known in North America. Further, evidence suggests this population is wholly natural in origin and maintenance. Particular care has been given to examine adults for legbands. A banded peregrine has not been seen in Zion during the current survey period nor do any park records report bands. In 1985, 9 of 12 adults were definitely unbanded; in 1986, 13 of 16 were known to have worn no bands. The remaining individuals were not observed long enough or repeatedly enough to verify the presence or absence of bands on both legs.

Unbanded peregrines may be assumed to be a natural population or at least one generation removed from captive-bred ancestry. Unbanded birds also are not

Continued on page 4



Prime habitat for peregrine falcons is this vast stretch of cliffs (for perching and nesting) and air (for swooping and soaring) at Zion National Park.

derived from manipulated eyries, where banding is routine. Furthermore, evidence suggests the Zion population is avoiding en masse major migration routes where banding often is intensive. This, coupled with sighting from March to October, has led to speculation that the population is non-migratory or disperses locally during winter months. However, no peregrine sightings have taken place this winter in or around Zion.

It is impossible to say whether the Zion population is reproductively stable. Data for the majority of the eyries exist only for three or four breeding seasons. Initial results are encouraging; reproduction for the past four breeding seasons has been 1.5 fledged/eyrie in 1984; 1.83 in 1985, 1.75 in 1986, and 2.77 in 1987. That this level of reproduction has been maintained in the face of eggshell thinning in excess of 20 percent may be due to the configuration of Zion's eyries. These are typically deep solution holes in the fine-grained sandstone so common in the park. Such sites offer excellent protection from intense sunlight and desiccating winds, and eyrie floors are usually a deep bed of floury sand. A thin-shelled egg may have increased survival chances under these conditions.

In sum, this monitoring program has found the peregrine population to be significant and unique. It will continue to be monitored on a non-interventive basis. Fortunately, it is isolated from most human disturbance by its distribution throughout very rugged and remote terrain. Also, it is contained within a national park mandated to protect natural resources; therefore it enjoys protection during the breeding season.

Hays is a Resource Management Specialist and Tibbitts is a Park Ranger at Zion NP.

Acknowledgements

The authors are indebted to volunteers Charles Turley, David Cash and Katie O'Reilly who assisted in the long hours of observation and demonstrated their personal commitment to the peregrines by donating so much of their free time.

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Crater Lake's Peregrine Falcon Challenge: A Soap Opera on the Cliffs

By Jim Milestone

Strong winds and blowing snow forced site attendant Brent Hetzler to retreat from his peregrine nest site observation point back to his remote cabin. It was 4:30 pm on May 2, 1988, and the female peregrine had been tucked back against the volcanic cliffs of Crater Lake's caldera wall all afternoon. She was brooding over the three down-covered chicks that were hatched on the ledge two weeks earlier. The storm precipitated over a foot of powder snow throughout that night in a series of flurries that crossed Crater Lake.

Some time that evening disaster struck. Under the veil of darkness and in the confusion of the blowing snow, an owl probably swooped in and killed the adult female and three chicks. The next morning Brent returned to his observation point only to find the lone adult male calling for his mate. "I looked through my scope and there was nothing there," Hetzler said. "All you could see was the empty ledge and some of the female's back feathers." A thorough investigation failed to locate the three chicks but the adult female's half eaten carcass was found 100 yards from the nest site at the base of the cliff.

This was bad news for Hetzler and for the staff of Crater Lake NP. It meant that Brent's efforts to protect the nest site for the past two months in the icy winds and snow had been in vain. "It was like losing family for me," Hetzler said. "I had been watching this pair since the year before." It also meant that the park had lost a successful restoration of naturally breeding falcons, the first in nine years.

In 1979, peregrine falcons nested for the last time without the assistance of man at Crater Lake NP. The lost site is the last natural eyrie in the state of Oregon. Since that time, the park's ranger staff, with assistance from the Oregon Department of Fish and Wildlife (ODFW) and the Predatory Bird Research Group (PBRG) in Santa Cruz, Calif. had been introducing, or hacking, young peregrine chicks into the park. Chicks flown in from the PBRG Center are allowed to mature in a hack box on the caldera wall. Fresh frozen quail are

thawed out daily and brought to the nest early in the morning before the young peregrines can see the site attendants. When the chicks are old enough to fly, the hack box is opened and the falcons take the big leap. This program has worked successfully at Crater Lake from 1983 thru 1986, with the release of 10 peregrine chicks during that time.

In 1987 and 1988, at least one of the chicks released returned to nest in the caldera. The adult male peregrine – recognized by the band on his leg – linked up with a wild female falcon. In 1987, the female laid four eggs at the caldera eyrie. The clutch of eggs was removed and replaced by two captively bred chicks. The eggs removed from the nest were incubated by PBRG and produced three young chicks; a fourth egg was added. The eggshells revealed an 18 percent thinning, resulting from industrial compounds (DDE and PCB). According to Lee Aulman of PBRG, "The peregrine falcon is a sponge for environmental contaminants."

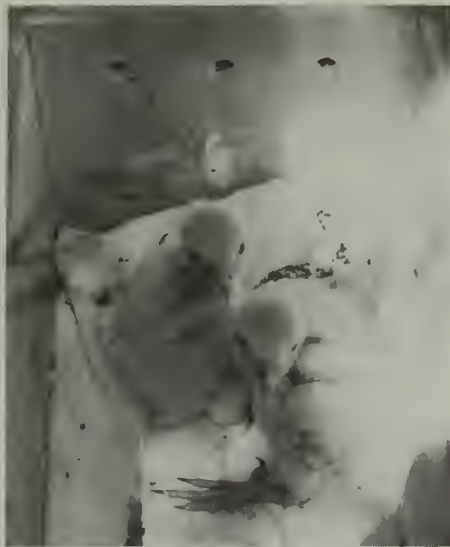
In 1987, the adult peregrines raised the two introduced chicks without any problems, until the night before the chicks were to fledge. That evening an owl swooped in and took one of the young. The remaining young falcon successfully fledged the nest and was seen flying along the rim of Crater Lake all summer with its parents.

With a track record like the one described above, one can imagine the frustration of those involved with the recovery program to see nature allow an owl to take an endangered species for dinner, especially from a family of peregrines that are a product of a nine year effort. The loss of peregrine falcons by other predators has been occurring at Crater Lake for centuries. It is only because of man's dependency on pesticides that the simple act of an owl, one snowy evening, turns this scene into a real tragedy for everyone involved.

The owl's return in 1988 to take not one, but three chicks and the prized adult female was a serious blow to the program. However, Park Ranger Jim Webster quickly developed an alternative plan. Having lost the oppor-



Hero of the peregrine soap opera, Brent Hetzler (center), is shown here with NPS Ranger Jim Webster (right), and Ralph Opp, a wildlife biologist with the Oregon Fish and Wildlife Dept., discussing plans for the next exciting episode.



Just call me Bigfoot might be the peregrine falcon chick's comment as it waits with its sibling in the carrying box before being planted in the prairie falcon nest on the caldera rim at Crater Lake. (Photo by Jim Milestone)

tunity to have the peregrines produce naturally, Ranger Webster arranged for ODFW and PBRG to respond with two new captively bred chicks. It was decided to cross foster the young with a neighboring pair of prairie falcons just across the caldera. The prairie falcon nest contained five young, which were removed and sent to another prairie falcon nest in southern Oregon. The prairie falcon adults quickly took charge of the new chicks and began to feed the young peregrines in the safety of their pothole, 200 feet above Crater Lake.

In late June the adopted peregrines fledged the prairie falcon nest and performed spectacular aerial displays for site attendant Hetzler, who had been watching this drama for three months. Meanwhile, on the far side of the caldera wall, the lone adult male peregrine falcon sailed on the thermals of the caldera cliffs waiting for an attractive female to appear. "I can sympathize with this fellow; I've been waiting for a female to show up for two years now myself," said Park Biologist Jim Milestone. Based on the remoteness of the site, he may be waiting a long time.

(Funding to assure continuation of the peregrine program at Crater Lake in 1989 has been eliminated in a series of drastic budget cuts.)

Milestone is a Biologist and Resource Management Specialist at Crater Lake NP.

Air Quality in the NPs

In support of the NPS interpretive initiative, Clearing the Air, the NPS Air Quality Division has produced a summary of the findings of the Air Quality Research and Monitoring Program of the National Park Service. The report covers the air quality research program responsibilities and activities, visibility, effects of visual air quality on visitor experience, criteria pollutants in NPS units, air pollution effects on biological resources, and NPS participation in protection of air quality resources.

Copies are available from the NPS Air Quality Division, P.O. Box 25287, Denver, CO 80225-0287.

Natural Disturbance And Management Of Wilderness Ecosystems

In recent years the importance of natural disturbances to the maintenance of natural ecosystems has become obvious to wilderness managers and ecologists alike. Natural disturbance and the management of wilderness ecosystems was the theme of a recent workshop jointly sponsored by the National Park Service and the Nature Conservancy. The workshop, conceived and organized primarily by Dr. Norm Christensen, professor of Botany at Duke University, with the assistance of David Parsons, Research Scientist at Sequoia and Kings Canyon (SEKI), and Willard Rose of the Nature Conservancy in North Carolina, began on Aug. 18, 1988, in conjunction with the Ecological Society of America (ESA) meeting in Davis, Calif. Made up of approximately 25 from each agency, the group included superintendents, interpreters, resource managers, and scientists.

The first day's presentations were also part of a featured ESA symposium. Peter White (UNC Chapel Hill and ex-NPS scientist) discussed Natural Disturbance and Ecosystem Management: Theory and Practice, and the paradoxes of preserving ecosystems that must change while at the same time being subjected to human management. He emphasized the importance of 1) understanding (the role of research), 2) managing (management decisions are inevitable), and 3) evaluating (providing feedback on the adequacy of your understanding and the effectiveness of your management) the occurrence and impacts of disturbance in natural ecosystems.

Other speakers presented case examples of the challenges posed by managing for natural disturbance: Mt. St. Helens (Peter Frenzen, USFS), the Yellowstone natural fire program (William Romme, Ft. Lewis College and Don Despain, NPS), fire as a disturbance factor in the southeast (Ron Myers, TNC), managing the cumulative effects of insects, parasites and fire (Dennis Knight, U/Wyo), the bison grazing - fire interactions on the mixed prairie (Allen Steuter, TNC), and impacts of anthropogenic air pollutants on the high elevation forests of New England (Charles Cogbill, Goddard College). Doug Sprugel (U/Wash), concluded with a discussion of the importance of temporal variability in understanding and managing disturbance regimes. He suggested that all too often the forest structure or animal community desired by park managers as the status quo has been selected simply because it was there at some point in the past.

The workshop continued on a field trip to Fresno, where Tom Nichols, SEKI fire ecologist, presented a slide show on the park's natural fire management program and David Parsons led a discussion of the issues and challenges that SEKI has faced in implementing a program of restoring natural ecosystem processes. An all day field trip to Sequoia NP followed. Plenary talks by David Graber (SEKI Research Scientist) on managing for uncertainty and Bill Tweed (SEKI Management Assistant) on visitor expectations, were preceded by a field trip through the Giant Forest. Organized field discussions were led by Christensen and members of the Park staff on monitoring, interpretation, research, management and critique of the Park's program for restoring fire as a natural element in the sequoia mixed conifer forest.

This program, taken as a vivid example of the role that both natural disturbance and man's interference can have in wilderness ecosystems, stimulated debate and discussion (Parsons will report on the controversy surrounding and the research approach to solving this issue

in a future *Park Science*.) That evening the group attended a campfire presentation by sub-district interpreter Greg Fauth on fire ecology in the Sierra Nevada.

On Saturday, working groups considered basic science issues and needs, management plan development, and monitoring. Participants stressed the importance of clearly articulating management objectives and making decisions based on the best possible information, including understanding the causes and effects of climate changes as well as other natural and man caused disturbances.

It is difficult to allow anything to go extinct if you can't be sure whether that extinction has been influenced by human activities. Thus, management decisions often become value judgments. There was general consensus that managing for disturbance is no simple matter, and that better information is needed about what resources we have, the ecological processes influencing them, and the consequences of alternative management scenarios.

The session organizers are preparing a report to the supporting agencies detailing the specific conclusions reached and plans are underway for a special issue of *Environmental Management*, in which the key presentations would appear.

Dave Parsons
Research Scientist
Sequoia/Kings Canyon NPs

NPS Book Explores Vista Preferences

Visual Preferences of Travelers Along the Blue Ridge Parkway is the title of Scientific Monograph #18 in the NPS science series. Edited by Francis P. Noe and William E. Hammitt, this book of nine chapters by 15 authors offers guidance on the best possible use of funds and manpower to protect and preserve the rural landscape.

In a foreword to the book, Blue Ridge Parkway Superintendent Gary Everhardt describes the NPS mission "to protect and preserve the integrity of these natural features as well as the cultural and natural visual resources that make the parkway so unique." The chapter on visual experiences of sightseers states one of the underlying causes of a dilemma faced in many parts of the National Park System: "Economic exploitation during our national history has increased the value of the remaining pristine lands. At the same time . . . economic development has supported the arts and humanities, which have taught us to appreciate nature and has provided the wealth that allows us to preserve national landscapes."

The book describes the visual and management preferences of sightseers and the analysis procedures used to identify them; explores the use of interpretation to gain visitor acceptance of vegetation management, and considers the influence of sociocultural factors on scenic preferences. The highly visual nature of the subject matter is illustrated in this 200-page book (ISBN 0-943475-00-7) with both full color and black and white vistas.

The book is available from Jim Wood, NPS science publications editor, Southeast Region, 75 Spring St. S.W., Atlanta, GA 30303; (404) 331-4916.

Science Conferees Urge Closer Communication

By Jean Matthews

Closer communication and more intensive education efforts both inside and outward from natural resource management agencies was the theme that surfaced at almost every session of the George Wright Society conference on science and resource management in national parks and equivalent reserves.

"Parks and Neighbors Maintaining Diversity Across Political Boundaries" was the stated title of this fifth in the series of science in parks conferences that began in 1976 and third to be arranged by the George Wright Society. The weeklong meeting, from Nov. 14-18, in Tucson, Ariz., attended by 300, was carried out in cooperation with the National Park Service and co-sponsored by the American Water Resources Association, Friends of Pronatura, the National Parks and Conservation Association, the North American Riparian Council, and the University of Arizona School of Renewable Natural Resources.

From the delivered papers and the poster sessions, it was apparent that tighter ties are forming, at both interdisciplinary and interagency levels, as federal, state, and local agencies and concerned citizen organizations gear up to meet the growing challenges posed by population growth, world climate changes, and rampant technology. The need to foster and quicken these ties and the educational outreach that will keep the public informed and involved was evident, both in the information presented and in the urgency of the presentations. The message seemed to be "We're practicing synthesis and outreach, but we need to do it even more vigorously and more effectively."

A "bullet treatment" of highlights from the conference follows, with full coverage of several of the major plenary session addresses to appear in forthcoming issues of the George Wright FORUM. The FORUM also will carry the titles, names and addresses of all the papers, posters, and those who delivered them so that interested persons may contact the authors directly.

- "I'm pleased to see the cultural emphasis in this conference. All parks are cultural in the sense that they serve the particular norms of the social matrix of the moment. The resources belong to the people as a whole and this affects how we should do the research. Bill Brown will assert, later, that culture drives the science effort. I agree.

"Examples of this are the recent Yellowstone fires and



Top: Tucson's Holiday Inn rolls out the welcome marquee for the George Wright Conference on Science in the Parks. **Second from top:** Saguaro NM field trip enlightened six busloads of conferees. **Third from top:** GWS banquet speaker Milford Fletcher (left), the SW Region's Chief Scientist, finds a rapt audience in NCR Chief Scientist Bill Alexander (center) and NPS Associate Director Eugene Hester. **Bottom:** Conference notables (from left), Kathy Hiatt, assistant conference coordinator; George B. Hartzog, Jr., former NPS director; Mrs. Hartzog; Alston Chase, author of *Playing God in Yellowstone*; Christine Schonewald-Cox, GWS President; Mike Kunzmann, UIAZ CPSU biologist and conference assistant; Roy Johnson, chief conference coordinator, and Ted Sudia, founder of the GW Society.

the development of the Williams Center tract at Manassas. The Yellowstone fires brought in 10,000 fire fighters and about 1,000 media members. The anguish/tragedy factor was high. This whole experience could have a profound effect on NPS fire policy.

"At Manassas, the 'hallowed ground' argument prevailed: Here, troops died; therefore, no exploitation. But this tract is just a chess piece in a much larger board of Civil War parks. If those larger issues aren't solved in the basis of the Williams Center decision, it will be a very hollow victory. The real danger is that an exhausted Congress will declare victory and walk away when the battle hasn't yet been joined.

"Because the NPS management decisions must be made in the public arena, the science on which they're based must be clearly articulated and easily available to the public mind. Thus, the two components of our scientific effort are quality (of the research) and acceptance (by the public)." **Denis P. Galvin, Deputy Director NPS, Washington Office**

- "Diversity – genetic, species, and community – demands a conservation network of all lands under federal stewardship – 740 million acres, managed for the most part as natural systems. This is an appropriate size, geographically. BLM and National Forest lands, at 43 and 25 percent respectively, are multiple use areas. National Parks (10%), National Refuges (12%), and 'other' such lands (10%), make up the special use areas – roughly one third of these federally administered lands. We need agreement from all the agencies on national goals, agency roles, and interagency strategies." **Dr. Winifred Sidle, USFS ecologist**
Director of USFS middle management education

- "Our cultural resources are largely uncatalogued and our museum system is not yet up to the tasks it faces. We have four broad goals: to identify and strategize the resources, to protect them, to interpret them as part of the larger cultural context, and to develop preservation guidelines and make them available to management.

"And perhaps just as importantly, we need to quit saying everything is just wonderful and start advocating and urging." **Jerry Rogers, Assoc. Dir. for Cultural Resources, NPS, Washington Office**

- "Until recently the NPS has excused its own lack of knowledge of the resources on the basis of our mission, which was to absolutely protect these resources. It's only since the pressure of outside events and decisions that affect our park resources that we have moved to find out exactly what we have and determine how it is threatened and how to protect it." **Eugene Hester, Assoc. Dir. for Natural Resources, NPS Washington Office**

- "Ecosystem management calls for recognition that ecosystem boundaries will change over time. It recognizes that fee ownership up to a boundary and beyond is no longer relevant. We need to develop and practice ecosystem management, to synthesize our understanding of the ecological and cultural dynamics of the system, to professionalize the management of the system, and to interpret, at every opportunity, the story that only a strong science program can write. It is a major educational task to communicate both the natural and cultural values of ecosystems, and the NPS has looked too much inward to its own needs rather than outward to educate the nation.

"The National Park Service should be a leader in

Roland Wauer Wins First Jacot Award

The first Francis H. Jacot Award "for outstanding contribution to the enhancement of natural resource management within the National Parks and Reserves" was awarded at the 1988 George Wright Society science conference to Roland H. Wauer, founder in 1982 of the highly successful NPS Natural Resource Management Trainee program. (See *Park Science*, Vol. 3, No. 2, p.3)

GWS President Christine Schonewald-Cox first announced establishment of the award, then introduced Jacot's widow, Jean, and presented her with an honorary Jacot award and a life membership in the George Wright Society.

The award was proposed by Tom Gavin, Western NPS Regional forester, in recognition of Jacot's outstanding lifetime achievements as a natural resource manager with the National Park Service, and will be given at each of the GWS biennial science conferences.

establishment and expansion of the ecosystem paradigm. Research must be pursued jointly by NPS scientists and those of other agencies and universities. Professionalization of NPS research is necessary – it's an outgrowth of the System and it should reach out and help solve problems *outside* as well as within the National Park System.

"Research should *drive* the management and the interpretation of the natural and cultural resources of the System." **Jerry Franklin, Ecologist**
University of Washington

- "The changes in science/management policy being discussed here are going to require a fantastic marketing strategy within the Service if such a changed mission is to be accepted and implemented."

Dave Parsons, Research Scientist
Sequoia/Kings Canyon NPS

- "There must be multiple roads to the 10 autonomous NPS regions. A budget line item is one road. Accountability of Regional Directors for the quality of their parks and the research therein is another. But these roads must stem from a strong central voice at the top."

Dr. Erv Zube, Landscape Architect
University of Arizona

- "The idea that people are separate from, and not a part of, nature is the dualistic cornerstone on which the conservation movement has been built. This dualism encourages a fortress mentality in parks (and a fieldism by superintendents.) Congress must speak unambiguously on this matter, and thoughtful individuals should discuss it publicly. Research people should remember that truth transcends institutional loyalties; it's the parks, not the Park Service, you're supposed to protect."

Alston Chase, Author

- "Congress should establish a National Register of Natural Places and a President's Council on Nature Preservation to resolve often conflicting public and private uses of lands adjacent to park boundaries that threaten ecological survival of our national parks. The Council should be empowered to promulgate 'compensable land use regulations' and aggrieved landowners should be allowed to sue the U.S. Government in their

Best Posters Recognized

The George Wright Society presented ribbons to the best posters in each of two sessions at the science conference in Tucson. A judging team evaluated the posters on communication effectiveness and scientific quality. Important characteristics of top posters were attractive graphic design, clarity of message, presentation of new methodology or concepts, and advocacy of an idea or management strategy. The best posters could be comprehended in a few minutes, could be read from a distance, caught the viewers attention, and left the viewer with a concise message. The judges selected posters covering research and resources management projects from cultural and natural resources.

Alaska

Carol McIntyre and John Dalle-Molle (Denali) and Michael Britten (Gates of the Arctic), *Developing a Long Term Monitoring Program for Breeding Golden Eagles*; Sandra Faulkner (Alaska Div. Cultural Resources), *Land of Thunder Mountain*;

Ron Sheetz (Harpers Ferry), *Restoration and Refurbishing of the Russian Bishop's House, Sitka National Historic Park*;

Jeanne Schaaf and Doug Gibson (Alaska Div. Cultural Resources) and Micheal Kunz (Gates of the Arctic), *Studies in Prehistory and Natural Sciences in Alaska National Parks*; and

Ted Birkedal and Paul Gleeson (Alaska Div. Cultural Resources), *The Lake Clark Sociocultural Project*.

Middle Atlantic

Beth Johnson and Carol Hansen (Delaware Water Gap), *Adjacent Land Use and Non-point Source Pollution Inventory at Delaware Water Gap National Recreation Area*.

Midwest

Kenneth Cole, N. Pavolovic, and K. Klick (Indiana Dunes), *The Paleoeological, Presettlement, and Historic Vegetation of an Indiana Sand Prairie: The Effects of Time, Water and Fire*;

Patricia Toczydlowski and Robert Stottlmyer (Houghton Tech, CPSU), *Attributes and Limitations of Ion Chromatography in Environmental Analyses*;

Susan Dlutkowski and Robert Stottlmyer (Houghton Tech. CPSU), *Ecological Factors Influencing Nineteenth-Century Forest Vegetation in the Parks of the Great Lakes Basin*;

Robert Krumenaker (Isle Royale), Ron Oveson (Mountain Shadow Consulting) and John Austin (Denver Service Center), *Computerized Visitor Tracking and Behavior Modeling for Isle Royale National Park*.

North Atlantic

John Portnoy (Cape Cod) and Michael Soukoup (North Atlantic Regional Office), *Gull Contributions of Phosphorus and Nitrogen to the Nutrient Budget of an Oligotrophic Cape Cod Kettle Pond*.

Pacific Northwest

Darryll Johnson, Thomas Swearington and Patricia Garcia-Gonzales (Univ. of Washington (CPSU), *Social*

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local federal courts. Acceptance of the ensuing settlement decision would constitute acquiescence with the compensable land use regulations."

George B. Hartzog, Jr.
NPS Director, 1963-1972

Geomorphology and Vegetation as Determinants Of Surface Water Chemistry at Denali

By R. Stottlemeyer and K. McLoone

The national parks and preserves in Alaska provide an excellent opportunity to acquire benchmark surface water chemistry against which potential human-induced change may be assessed. Such undisturbed systems make it possible to assess the role of natural ecological factors in effecting noted variations. Much study has taken place on understanding biogeochemical cycles within a watershed context – mostly intensive studies, concentrating on one or a few drainages. Hypotheses from such studies regarding the regulation of stream chemistry tend to be confined to specific areas.

What is needed for the expansive Alaskan areas are general hypotheses more widely applicable to a given region. Our approach was to select a large number of small watersheds stratified by geologic substrate, aspect and elevation, in order to 1) obtain baseline surface water quality data and 2) examine some of the natural factors responsible for noted variation in water chemistry, especially those chemical species having the most potential value as indicators of ecosystem change.

In New England the use of long-term trends in surface water chemistry to detect trends in anthropic atmospheric deposition has been adequately demonstrated. Such data also permit projecting future surface water change should present air quality change. But there are numerous sources of *natural* variation in surface water chemical trends such as elevation, aerial extent of bedrock type, and ecosystem succession. In Denali another factor may be topographic aspect which determines, to considerable degree, the presence or absence of permafrost.

Denali National Park and Preserve (2.5 million ha),

located about 600 km east from the coast of the Bering Sea, occupies the northernmost portion of the Alaska Range in the Pacific Mountain System. Geology here is dominated by Precambrian slate and marble, quartzite and mica-quartz schist; to a lesser extent Mesozoic basalts, sandstones and shales, and Tertiary granitics and sandstones, shales and conglomerates. The north and west sections of the study area are dominated by Quaternary gravel and glacial deposits. The region's climate is continental, with large diurnal and annual temperature variation. Mean annual precipitation varies from 50 cm at lower elevations, where one-third occurs as snow, to 200 cm at high points. Lower elevations of the park are underlain by isolated masses of permafrost; higher levels have discontinuous permafrost.

The sampled watersheds occur in the eastern and central portions of the park in headwaters of the Teklanika, Toklat, McKinley and Kantishna River drainages. Most watersheds above 1000 m elevation are vegetated by low productivity moist or barren and sparse dry tundra (Fig. 1). At lower elevations and on south facing slopes mixed evergreen and deciduous forests prevail. Over 60 watersheds were sampled in the fall of 1985. A subset of >20 were sampled seasonally in 1987, and intensive study of the effects of vegetation on surface water quality was continued in a few carefully selected watersheds (Fig. 2). Access to most sites was by helicopter. In each watershed a stream sampling site was selected where discharge measurements could be taken by Pygmy meter. The determination of pH, alkalinity, and specific conductance was completed upon return to base camp. Samples for ionic analyses were shipped in coolers to our laboratory at Michigan Tech.

Surface waters of Denali are concentrated and very well buffered. Only one stream had significant levels of dissolved carbon. Stream chemistry was dominated by calcium, magnesium, bicarbonate and sulfate. In no instance did sulfate concentration exceed bicarbonate –

testimony to the high natural buffering and near absence of atmospheric contaminant input in the park. The pH increased from 6.5 in the most dilute stream to 8.7 in the most concentrated, where there was evidence of calcium carbonate precipitating out. This was found in watersheds with a basalt-rhyolite bedrock (Teklanika Formation).

Stream chemistry concentrations greatly exceeded those found at multiple sites in Glacier Bay and Lake Clark NPs. This reflects regional geologic differences. Bedrock at Lake Clark (*Park Science*, Vol. 8, No. 4, pp. 23-24) and Glacier Bay (*Park Science* Vol. 8, No. 3, pp. 20-21) is dominated by Tertiary intrusive rock while Denali is dominated by Mesozoic and Quaternary sedimentary rock. Stream nitrate values at Denali were slightly higher. This likely is due to the combination of nitrogen fixers in these predominantly early successional headwater ecosystems, relatively low biological uptake and minimal nitrate retention in very young, poorly developed soils.

To further evaluate the role of bedrock character we related stream water chemistry to rock type by grouping bedrock types dominated by similar geochemistry. Stream water from watersheds with bedrock dominated by calcium and potassium feldspars or mixed sediments and gravels was significantly higher in concentration of calcium, magnesium, and potassium than stream water from watersheds with bedrock dominated by sodium feldspars or volcanics. Conversely, the concentration of these chemical species was significantly lower in streams draining watersheds with volcanic substrates, clear evidence of the geochemistry of this substrate. Such watersheds are found on the north slope of Mt. McKinley (Fig. 1). The till observed in these drainages consisted solely of granite, which is the only bedrock upslope from these watersheds.

Stream concentrations of sulfate were high in the Kantishna Hills region, apparently due to high frequency of sulfide bearing minerals associated especially with

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Science Applications to National Park Management;
Regina Rochefort and Stephen Gibbons (Mt. Rainier),
Impact Monitoring and Mitigation in a Subalpine Meadow;

Gerald Wright (Univ. of Idaho CPSU), *Integrating Data Management with Resources Monitoring.*

Rocky Mountain

Mark Schroeder (Grand Teton), *The Bison Management Controversy in Jackson Hole, Wyoming – How Many are Too Many?*

Southwest

Milford Fletcher, and Deborah Pfenninger (Southwest Regional Office), *Methodology to Count Mexican Free-tail Bats;*

William Shaw, Audrey Goldsmith, Paul Krausman, and William Mannan (University of Arizona CPSU), *Relationships between Adjacent Land Uses and the Wildlife Resources of Saguaro National Monument.*

Western

Thomas Gavin (Western Regional Office), *Proposed Western Region Fire Monitoring System.*

Inter-Regional

Ronald Sundell (Argonne National Laboratory), *The Use of Spatial Analysis in Determining Appropriate Park Boundaries;* and

John Peine (Great Smokies), Ted Simmons (Gulf Islands), and Richard Cunningham (Western Regional Office), *Migratory Bird Watch.*



Figure 1. The granite substrate of the Cache Creek watershed results in very dilute, relatively sensitive stream water.



Figure 2. Remote automated monitoring station to assess effect of temperature, moisture, and radiation on vegetation production, decomposition, and nutrient cycling.

vein-faults. Some instances of high heavy/trace metal concentrations also were found in streams undisturbed by mining. Such levels likely are the result of mineral-rich springs. However, at our study sites the high pH of the stream rapidly complexes many if not most of the trace metal input thus reducing or eliminating its potential for biological impact.

It is always desirable to be able to extrapolate from such results, and predict stream water chemistry in other park drainages. Use of such easily measured physiographic characteristic as watershed area, elevation, topographic aspect would be the simplest and most economical. Using step-wise multiple regression we tested a number of models using basin area, elevation, difference in elevation within the drainage, and aspect, but found no single or combination of variables that would account for a significant amount of the noted variation in stream chemistry. This points to a need for more baseline spatial data and further understanding of natural factors responsible for variation in some of the key tools, (as water chemistry), we use to detect long-term change.

Precipitation chemistry does not appear to be a major factor responsible for seasonal variation in surface water chemistry. The only possible exception was nitrate concentration in precipitation. The relatively high nitrate concentration observed in spring, coupled with snow melt losses of nitrate and low biological uptake, could all be factors in why stream nitrate concentration is high in early summer.

The data give some quantification of the relationship of geomorphology to surface water chemistry. The influence of bedrock quality can be seen clearly in those inorganic chemical species not generally found to be

ecologically limiting. However, the presence of nitrate, a commonly limiting nutrient in terrestrial ecosystems, in stream water was not related to bedrock since it is of biological origin. Nitrate is also a common atmospheric contaminant, and while such inputs are not now high in Denali there is potential for their increase in the near future. In the summer of 1988 we examined several watersheds with significantly different concentrations of stream water nitrate to find out what process(es) might be responsible. Since nitrification is the most probable source of this output and is an acidifying process, this subgroup of watersheds appears to contain good sites for obtaining assessment of the effects of ecosystem biological differences (vegetation type, succession) on basic change in watershed soils and therefore surface water chemistry.

The time and fiscal constraints of our study will not permit addressing all sources of natural variation in key ecosystem indicators of stress. However, our design should quantify some of the major sources. Further, the stratified approach in watershed selection and extensive coverage of site types now would permit deductive site selection for long-term inventory and monitoring. Because inventory and monitoring is a substantial commitment of funds and time, site selection must be made with great care. Most important, site selection must not be based upon short-term considerations. Objective evaluation is necessary to get sites that have the highest probability of yielding answers to a wide range of environmental threats, some not yet even perceived.

Stottlmyer is a Research Scientist and McLoone is a Research Assistant at the NPS Great Lakes Area Research Studies Unit.

information crossfile

A 25-minute film entitled "Landscape Linkages" describes the adverse effects on our world resulting from the fragmentation of our forests and other wildlife habitat. The film, produced by Dr. Larry Harris of the University of Florida Department of Wildlife and Range Sciences, examines the loss of wide ranging species (half a million acres is minimum range for black bears), the loss of genetic diversity and integrity from within species (e.g. inbreeding depression shows up early as loss of libido), loss of "area sensitive" or "interior" species (e.g. 47 percent of species known to breed in hardwood habitat no longer occur in the fragments of habitat left in Florida), and the increasing dominance of "weedy" species (e.g. the nest parasitism of cowbirds is wiping out the warblers in Florida).

The choices given are (a) to allow the threatened plants and animals to dwindle away, or (b) to devise strategies for reconnecting wildlife islands and creating migratory corridors in the spirit of fish ladders, elevated pipelines and highway underpasses. A forward looking "community preservation" approach is suggested in this film.

Copies are available from Florida Films, P.O. Box 13712, Gainesville, FL 32607 for \$19.95.

The *Wall Street Journal*, on its op-ed page Nov. 23, 1988, featured an article by former NPS Director George B. Hartzog, Jr., under the heading "Take Politics Out of the National Parks." The article was largely the address Hartzog delivered to the NPS science conference in Tucson last November, an excerpt from which appears in this issue on page 7. Hartzog's entire address will be carried in the next George Wright Society FORUM.

A debate between Alston Chase, author of *Playing God in Yellowstone*, and NPS Research Scientist Dave Graber was scheduled at press time to take place on Dec. 7, 1988 before the participants in the NPS training session on natural resource management protection and law, for superintendents and mid-level managers. The subject was "the appropriateness of management intervention in natural processes of wilderness national parks."

Jerry Franklin, a scientist with the USDA Forest Service and also the Prentice and Virginia Bloedel professor of ecosystem analysis at the University of Washington's College of Forest Resources, was the first recipient of the Wilderness Society's Olaus and Margaret Murie Award. The honor carries a \$1,000 cash prize and is given each year to a "front-line federal or state land management employee who has shown exceptional dedication to the principles of natural resource conservation and protection of America's natural heritage.

Franklin is known for his field work on old-growth forest eco-systems. It was his "pulse study" of the Hoh River drainage in Olympic NP – a precedent setting approach to interdisciplinary study of an ecosystem – that was the cover story for the first issue of *Park Science*, in October 1980.

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Information Crossfile, cont.

Wilderness Society President George Frampton, Jr., credited Franklin with advancing the nation's understanding of ancient forests. "Thanks to Franklin," Frampton said, "we have gone from viewing old-growth forests as biological graveyards to appreciating them as complex and diverse eco-systems teeming with life."

**

Policy Studies Review, Vol. 7. No. 2 (Winter 1987) contains 12 papers presented at a symposium on outdoor recreation policy which took place in 1987 under a cooperative agreement between Georgia State University and the National Park Service. Contributors include Southeast Regional Chief Scientist F.D. Dottavio and NPS Research Sociologist Francis P. Noe. Dottavio and two other authors (Joseph T. O'Leary and Francis A. McGuire) examine the role of the nationwide recreation survey in providing information for outdoor recreation policy analysis. Noe, together with Robert Snow and Gary Hampe, discuss visitor use of the outdoors and the missing links between policy and demand.

Also contained in this 472-page book is an article by Craig W. Allin on "Park Service vs. Forest Service: Exploring the Differences in Wilderness Management."

The **Policy Studies Review** (ISSN 0278-4416) is one of two periodicals published by the Policy Studies Organization – put out by the Arizona State University School of Justice Studies and appearing in August, November, February and May. Contact is Policy Studies Organization, 361 Lincoln Hall, 702 South Wright, University of Illinois, Urbana, IL 61801.

**

An expanded issue of the new quarterly **Earthquest**, deals with polar research and the new interdisciplinary focus on that area. The issue, Vol. 2, No. 2, combines the spring and summer issues. **Earthquest** is a publication of the Office for Interdisciplinary Earth Studies (OIES) of the University Corporation for Atmospheric Research (UCAR), P.O. Box 3000, Boulder, CO 80307-3000.

The polar research issue announces plans for a new journal, **Arctic Research**, to be published by the National Science Foundation on behalf of the Interagency Arctic Research Policy Committee and in cooperation with the Arctic Research Commission. It will contain reports on current and planned U.S. government-sponsored research in the Arctic, reports of meetings of the IARP Committee and AR Commission, summaries of other current and planned arctic research, and a calendar of forthcoming local, national and international meetings on the subject. For subscriptions, write the Coordination and Information Section, Division of Polar Programs, Room 620 National Science Foundation, Washington, D.C. 20550.

**

Umbrella Films, a production company specializing in "projects that present a balanced view of issues relating to the environment and public policy," has eight new films available under the heading of case studies in environmental policy. Among them is a 28-minute video tape entitled "The Law of Nature: Park Rangers in Yosemite Valley." This finalist in the American Film and Video Festival is praised by Dr. William O. Dwyer, director of the park ranger training program at Memphis State University, as "a sensitive treatment of the difficulties that park rangers face..."

The film treats rangers as "most often naturalists both by training and inclination" and examines their role in today's heavily visited parks where they "often find

themselves acting almost exclusively in a law enforcement capacity."

The films and tapes may be rented or purchased from Umbrella Films, 60 Blake Road, Brookline, MA 02146; (617) 277-6639.

**

Ted Fremd, NPS paleontologist with the John Day Fossil Beds NM in Oregon, reports attending the 48th annual meeting of the Society of Vertebrate Paleontology in Alberta, Canada recently. Dinosaur NM and Petrified Forest NP also were represented. Dan Chure and Jack McIntosh of Dinosaur gave a paper, Dinosaur NM: Paleontology in the Public Eye," and Fremd presented results of high-resolution mapping of vertebrate fossil accumulations and the implications for paleoecological models.

With regard to the Society's overwhelming vote to reject the National Academy of Sciences recommendation that federal land managers should allow the collection and commercial sale of paleontological specimens, Fremd told the conferees: "Commercial collecting encourages a 'marketable commodity' perspective, and it isn't profitable for fossil traffickers to document the data associated with the specimen in the field, even if they knew how. As a result, the intrinsic value of the objects – recognizable by scholars – is irretrievably lost."

Fremd points out that the NAS committee which made the recommendation included a dealer of fossils.

**

The Potential Effects of Global Climate Change on the United States is the title of a draft study prepared by the EPA Office of Policy, Planning and Evaluation and now awaiting the agency's Science Advisory Board's review. Four regions – the Great Lakes, the Southeast, California, and the southern Great Plains – were studied at the request of the Senate Environmental and Public Works Committee with the aim of providing some broader sense of the magnitude of the effects of greenhouse warming on a regional basis as well as on the U.S. as a whole.

The report is meant to assist researchers and policy-makers in identifying possible areas of research and it calls on federal and state policy-makers to institute long-term planning efforts for adapting to climate change. In particular, the report suggests that federal and state wildlife and fishery managers begin to consider climate change effects in siting refuges and to examine setting up migratory corridors to improve the ability of various species to move to new habitat.

**

A project to identify space-science research objectives extending into the 21st century, begun two years ago on the heels of the Challenger tragedy, has issued a hefty, 7-volume report, suggesting what *Science News* writer Jonathan Eberhart calls "roadmaps for 30 years of tomorrows."

One of the six sections, each of which begins by projecting existing or planned activities in its field through 1995 and then looks ahead through 2015 A.D., is entitled "Mission to planet earth." This section addresses questions of global changes and habitability on earth, proposes a satellite-based observing system provided in part by other countries. Five geostationary satellites, two to six polar-orbiting platforms, and a complementary network of earth-based sensors would provide a regular infusion of data for theoretical modeling. The panel of scientist/authors conclude that "this accomplished, scientists could use the entire earth as a laboratory."

**

According to records dating back about a century, global temperatures have increased by .6 to .7 degrees Centigrade, and the five highest average temperatures have occurred in the 1980s. James Hansen, a climate expert at the NASA Goddard Institute of Space Studies in New York City told a Senate energy committee (reported in *Science News* Vol. 134, No. 1) that he is 99 percent certain the accumulation of greenhouse gases is responsible for the warming trend.

"Such patterns agree with computer models that simulate how the climate should react to increasing concentrations of greenhouse gases," *Science News* reports. These gases are principally carbon dioxide, methane, nitrous oxide and the ozone-destroying chlorofluorocarbons. These gases are produced through burning fossil fuels, leveling forests, fertilizing fields and many other natural and industrial processes; they trap infrared radiation emitted by the earth's surface, knocking the world's climate out of balance and "sending it reeling toward a warmer equilibrium temperature."

**

"Genetics and Demography in Biological Conservation" by Russell Lande in the Sept. 16, 1988 issue of *Science*, cites two cases where management plans based primarily on population genetics actually threatened the existence of the populations they were designed to protect because basic demographic factors were ignored. The northern spotted owl and the red-cockaded woodpecker were the examples cited.

The author's premise is that demography is usually of more immediate importance than population genetics in determining the minimum viable sizes of wild populations. His abstract reads in part:

"Predicting the extinction of single populations or species requires ecological and evolutionary information. Primary demographic factors affecting population dynamics include social structure, life history variation caused by environmental fluctuation, dispersal in spatially heterogeneous environments, and local extinction and colonization. In small populations, inbreeding can greatly reduce the average individual fitness, and loss of genetic variability from random genetic drift can diminish future adaptability to a changing environment." Lande suggests that the practical need in biological conservation for understanding the interaction of demographic and genetic factors in extinction "may provide a focus for fundamental advances at the interface of ecology and evolution."

**

In an article on "Artificial Intelligence and Natural Resource Management" in *Science* (Vol. 237, 262-267), R.N. Coulson, L.J. Folse, and D.K. Loh explore the use of three new procedures in providing a new look at classic problems in systems analysis. Of particular significance, they find, are (1) integrated expert systems, which link management models with natural resource models; (2) intelligent geographic information systems (GISs), which permit interpretation of relations within and among landscape data themes, and (3) artificial intelligence (AI) modeling of animal behavior and interaction with the environment.

Landscape ecology, the study of structure, function, and change in heterogeneous land areas composed of interacting ecosystems, deals – they explain – with the level of ecological organization that service agencies such as the Park Service are charged to manage. It has arisen from the need to understand four things: (1) development and dynamics of pattern in ecological phenomena, (2) the role of disturbance in ecosystems, (3)

regional highlights

Alaska Region

Thirty-seven participants from more than two dozen universities and agencies presented research papers at the 2nd Glacier Bay Science Symposium, held Sept. 19-22, 1988 at the Glacier Bay Lodge. Proceedings of the symposium will be printed in 1989. The next symposium is planned in 1993.

A trip to Aniakchak NM&P in August, 1988 by Grumman Goose made Regional Chief Scientist Al Lovaas and Fishery Biologist Ross Kavanagh, two of the relatively few people to have visited every Alaska NPS area at least once; Al after 7½ years in the Alaska Regional Office, Ross after 10 years. The party included Stan Ponce, chief of the Water Resources Division, Fort Collins; Nancy Deschu of the Alaska Region's Division of Minerals Management; and David Manski, then Resource Management Specialist for Aniakchak. They were shown around Surprise Lake in Aniakchak Caldera by Will Cameron and Kristine Sowl who were conducting a baseline limnological study there under the direction of Dr. Gary Larson of the Oregon State University CPSU, and also were able to briefly touch down on the outer coast of Aniakchak where Frank and Penny Starr were conducting coastal surveys.

Plant collections located in herbaria of national parks in Alaska have been entered into the Automated National Catalog Program. Taxonomic name; collection location; elevation; habitat; and in many cases, latitude and longitude or township, range, and section data are included for each plant. The Automated Catalog fields are associated with dBASE III PLUS. Diskette copies with park records may be obtained from the Regional Curator, Alaska Region.

Layne Adams worked on a doctorate degree at the University of Minnesota, St. Paul during the 1988 fall quarter. He will use his work on caribou calf predation at Denali for a dissertation.

The Survey and Research Branch of the Cultural Resources Division completed a third season of the mining inventory. Anne Worthington and crew surveyed

in Wrangell-St. Elias and Gates of the Arctic NPs, documenting 29 historic and 4 prehistoric sites. A.J. Lynch and crew surveyed the Kantishna and Dunkle Region of Denali NP, documenting 10 historic and 11 prehistoric sites. Archeological surveys of proposed land exchanges also were conducted in these areas. Mike Kunz and Peter Phippin conducted a survey of proposed exchange lands in the Anaktuvuk Pass area, Gates of the Arctic, where one stratified site and small scattered sites were found in the side valleys. At Denali, Wayne Howell and crew documented 3 prehistoric sites in the Swift Fork River and Ruth-Tokositna areas during the first year of a two-year survey.

Roger Harritt initiated a four-year data recovery project during the summer at Cape Espenberg, Bering Land Bridge National Preserve. Primary objectives are data recovery from the eroding beach ridges and investigation of prehistoric occupation of the area. Preliminary results from 10 weeks of work last summer indicate that the Cape was utilized intermittently in the Arctic Small Tool tradition and Ipiutak times, and heavily from the Kotzebue through late prehistoric periods. Vegetational features were used in identifying site locations. Recovered artifacts included lamps, pottery, ivory figurines, and slate blades.

Janet Kidd, Alaska Quaternary Center, U/AK, Fairbanks, continued paleo-environmental investigations at thaw lakes in the northern coastal plain of Bering Land Bridge National Preserve. The study was begun in 1986 in conjunction with the Bering Land Bridge Archeological Site Inventory. Jim Jordan and Owen Mason, both of U/AK, Fairbanks, continued research in the Preserve.

The second year of the Cape Krusenstern Archeological Site Inventory was completed during 1988 under the direction of Doug Gibson and Dale Vinson: 152 new sites were found during the first two years of this three-year project.

A testing program at Klondike Goldrush NM continued under Ray Depuydt during 1988. The program is part of a historic building renovation currently underway in downtown Skagway. Karl Gurke also conducted arch-

characteristic spatial and temporal scales of ecological events, and (4) interactions among multiple ecosystems (landscape elements).

The article describes in some detail the ways conventional GIS can be dramatically enhanced by incorporation of AI in its design.

"O beautiful, for oil leases" was the headline for a U.S. News and World Report story in the Aug. 29/Sept. 5, 1988 issue. The subhead read: "The real threat to the national parks lies just beyond their boundaries."

The article strongly presents "the fact that fires actually benefit wilderness areas by clearing undergrowth and dead trees, thus regenerating the forest and improv-

ing wildlife habitat" and then goes on to consider "the real threat to America's first and most ecologically pristine national park: An ever tightening circle of mining, oil wells, timber clear-cutting, geothermal leasing, vacation homes and growing communities that is closing in on Yellowstone from every direction."

The four-page report airs views from both sides of the conservation struggle and concludes that "the partial answer, of course, is more and bigger parks," but concedes that:

"Out West, where the private-land ethic is sacrosanct and Park Service motives are always regarded with jaundiced suspicion, favoring expansion can be political suicide, and creating new parks or adding to others will be difficult."

ecological clearance projects at the administration site and Kalem tract in Skagway. At the Kalem tract the original foundation (ca. 1898 to 1932) was located, associated with Goldrush-period artifacts.

Archeological compliance projects directed by Paul Gleason in Katmai NP resulted in discovery of a new site locality with at least four occupations representing a 4,000-year time span. A Camp phase (880 +/- 100 years) house structure and midden also were tested. A complete Camp phase pottery bowl with no known analog was found.

Under the NPS Archeological Assistance Program, Pat McClenahan and Jeanne Schaaf observed conditions at the Palugvik site on Hawkins Island, Prince William Sound (a National Historic Landmark). The site has been significantly disturbed by pothunters.

Bering Land Bridge National Preserve: an Archeological Survey, a two-volume report by Jeanne Schaaf was released recently. Limited copies are available from the Division of Cultural Resources, Alaska Regional Office (907/257-2663).

Mid-Atlantic NP

Shenandoah NP recently hosted the first NPS Geographic Information Systems workshop. The workshop was organized by Allison Teetor, Shenandoah, and Harvey Fleet, GIS Division in Denver, and was attended by approximately 100 NPS staff from throughout the service. Much of the workshop consisted of presentations from parks that already have GIS capabilities regarding GIS hardware and software, problems encountered, GIS applications, and recommendations for new users. Other topics included the role of the GIS Division, new servicewide hardware contracts, and comparisons of GIS, CADD, and other more simplistic mapping packages (eg. Altas Graphics).

A detailed report of this conference by GIS Division Chief Harvey Fleet will appear in the Spring issue of *Park Science*.

A set of guides designed to help standardize the writing, reviewing and reporting of research proposals and results has been completed and adopted by the MARO Science program. A research proposal guide informs researchers of our research mission, procedures for writing and submitting research proposals, and collection permits. A research reporting guide informs researchers of the reports and other products required, along with procedures for writing, formatting, and submitting research reports. Each of these guides has a complementary reviewer's guide designed to assist park managers in reviewing research proposals and research reports. Copies of these guides may be obtained from Chief Scientist John Karish (address inside front cover).

Jeff Marion reports the availability of an article titled "Recreation Impacts in Some Riparian Forests of the Eastern United States" published in *Environmental Management* (1988, Vol. 12(1):99-107). The article describes results from investigations of ecological impacts on camp and picnic sites at three MARO park units, including findings relating to differences in types and amounts of recreational use and environmental site

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Regional Highlights

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characteristics. Reprints may be obtained from Jeff at Star Route 38, Milford, PA 18337.

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Proceedings from a March 1988 Scenic Rivers Water Quality Workshop at Delaware Water Gap NRA are available from Beth Johnson, Star Route 3B, Milford, PA 18337. The workshop brought together local, state, and federal agencies concerned with the management of water quality in the Upper and Middle Delaware Scenic and Recreational River.

* * *

The abrupt reassignment of John Karish from Mid-Atlantic to North Atlantic Regional Chief Scientist, indicated at the end of the R, T & E article on page 20 of the Fall 1988 issue of *Park Science*, was an editorial error, not an administrative decision. The editor is truly sorry; Mike Soukup of the North Atlantic Region is relieved.

Rocky Mountain Region

On Oct. 3, 1988, a meeting called by Grizzly Bear Recovery Coordinator Chris Servheen was held at Mammoth, Yellowstone NP to discuss future monitoring and research necessary to document the effects of the 1988 Yellowstone area fires on the grizzly bear population. The meeting provided an opportunity for 14 of the most knowledgeable people in the Yellowstone ecosystem to discuss fire impacts and issues. The identified research needs summarized by topic, were: (1) bear movements related to the fires; (2) habitat effects related to bear foods; (3) survivorship; (4) human-bear conflicts, and (5) vegetation structure.

General assignments of responsibility were made for certain study needs and a supplemental funding budget was prepared.

Pacific Northwest

James K. Agee, research biologist and CPSU leader for the NPS at the University of Washington, has resigned from the Park Service after 15 years to accept a position as professor and chairman of the UWA Forest Resources Management Division in the College of Forest Resources. His current research projects in the PNR national parks will continue, as will the liaison role he has had with park and wilderness issues.

* * *

Doug Houston served as the NPS scientist on a 5-member U.S. delegation to a joint workshop on park planning and management held in Poland, Oct. 21-31, 1988. Poland has 15 national parks concerned primarily with the consequences of nature. The total combined area of these parks is about 1,400 km², about 40 percent of the area of Olympic NP. The sizes, locations, and levels of human use in and out of the Polish parks limit options for management. Additionally, the rate of environmental degradation from air pollution/acid rain is frightening.

Houston reports that the trip was a real educational experience, and that his education extended well beyond the management of parks. The U.S. delegation will write a report for *Park Science* on their perceptions of park management in Poland.

Western Region

Donald Gardner, NPS research scientist at the CPSU/Univ. of Hawaii, attended the 5th International Congress of Plant Pathology at Kyoto, Japan in August 1988. Gardner, a recognized authority on plant rust fungi in

natural systems, served as a session chairman and presented a paper on taxonomy, morphology, distribution, and significance of the legume tree rusts of the world.

Gardner's principal research involves biocontrol of alien plants in Hawaiian NPS areas. Since potential biocontrol agents usually come from the countries of alien plant origin, biocontrol programs require cooperation and assistance from researchers on an international basis. Following the conference, which was attended by scientists from 77 countries, Gardner was invited to visit the Tsukuba University campus to review research involving plant rust fungi and interact with faculty and graduate students.

* * *

Clifford Smith, Director of the University of Hawaii CPSU, reports publication by the CPSU of *Checklist of Vascular Plants of Hawaii Volcanoes National Park* by P.K. Higashino, L.W. Cuddihy, S.J. Anderson, and C.P. Stone, published as Tech. Report 64; and *Bryophytes and Vascular Plants of Kipahulu Valley, Haleakala National Park* by the same authors, published as Tech. Report 65.

* * *

HAVO Research Scientist Chuck Stone presented sessions on island biogeography at the Western Region Interpreters Workshop in San Diego Oct. 31, 1988.

* * *

Two new technical reports out of the NPS Cooperative Park Resources Studies Unit at U/Cal Davis are now available from the Western Region. TR #31, by Michael L. Avery and Charles van Ripper III, is "An Evaluation of the California Wildlife-Habitat Relationships Data Base for Predicting Bird Community Composition in Pinnacles National Monument." TR #32, by Gregg Riegel, Sarah Greene, Mark Harmon and Jerry Franklin, looks at "Characteristics of Mixed Conifer Forest Reference Stands at Sequoia National Park." The latter publication contains six large maps (enveloped inside the back cover) – stem maps from each of the reference stands.

In addition, the Annual Report of all research undertaken by the CPSU in 1987 also is now available.

* * *

Herbicide tests on 10 species of alien plants in Hawaii have produced some promising results, although it is too early to determine final results in most cases. ESCORT, ARSENAL, GARLON 4, and GARLON 3A are all giving 90%+ control of *Rubus ellipticus* as cut stump treatments after 12 months. GARLON 3A and 5% ROUNDUP treatments gave 100% control of *Passiflora mollissima* after 12 months as cut stump treatments. Undiluted GARLON 4 gave 95% control as a cut stump treatment on *Psidium cattleianum*, but rooting of cut slash in wet areas is a problem. Undiluted GARLON 3A or GARLON 4 gave 80% control of *Tibouchina urvilleana* after 22 months in cut stump treatments, but the cut slash must be treated with 1% v/v GARLON 4 in water to prevent rooting. Subsequent retreatment of resprouts is necessary at 6-month intervals for 2 to 3 years after initial treatment.

Southeast Region

A new 72-page publication, *Wildlife in the Everglades and Latin American Wetlands* (George H. Dalrymple, William F. Loftus and Frank S. Bernardino, Jr., editors) is now available from South Florida Research Center, Everglades NP, Homestead, FL 33030. It contains abstracts, in English and Spanish, of the proceedings of the First Everglades NP Symposium, held in 1985 in Miami.

Sponsored by Everglades NP, UNESCO, and Florida International University, the symposium brought together more than 40 specialists in wildlife to share information on the diversity, ecology, and management of wetlands wildlife. To promote further cooperation and information transfer, Everglades NP funded publication of the proceedings in both English and Spanish.

Midwest Region

Larry Kallemeyn, Voyageurs NP's aquatic research biologist, reports that results from a series of studies detailing with the impacts of regulated lake levels on the park's aquatic ecosystem (see *Park Science* 4(1), p. 18) have recently been published in the Midwest Region's Research/Resource Management Report series. The seven reports, which were prepared with the assistance of the Midwest Regional Office and Jim Wood, NPS science editor, are:

Kallemeyn, L.W. 1987. Effects of regulated lake levels on northern pike spawning habitat and reproductive success in Namakan Reservoir, Voyageurs National Park. R/RM Report MWRO-8.

Thurber, J.M., and R.O. Peterson. 1988. Effects of regulated lake levels on muskrats in Voyageurs National Park, Minnesota. R/RM Report MWRO-9.

Route, W.T., and R.O. Peterson. 1988. Distribution and abundance of river otter in Voyageurs National Park, Minnesota. R/RM Report MWRO-10.

Smith, D.W., and R.O. Peterson. 1988. The effects of regulated lake levels on beaver in Voyageurs National Park, Minnesota. R/RM Report MWRO-11.

Kraft, K.J. 1988. Effects of increased winter drawdown on benthic macroinvertebrates in Namakan Reservoir, Voyageurs National Park. R/RM Report MWRO-12.

Reiser, M.H. 1988. Effects of regulated lake levels on the reproductive success, distribution, and abundance of the aquatic bird community in Voyageurs National Park, Minnesota. R/RM Report MWRO-13.

Cuthbert, F.J., and A. Rothstein. 1988. Factors influencing the distribution, abundance, and reproductive success of Ospreys in Voyageurs National Park, Minnesota. R/RM Report MWRO-14.

Another recent report dealing with this issue is Kepner and Stottlmyer's "Physical and chemical factors affecting primary production in the Voyageurs National Park lake system" (Report #29 Michigan Technological University's Great Lakes Area Resource Studies Unit Technical Report Series). Kallemeyn has published a paper "Correlations of regulated lake levels and climatic factors with abundance of young-of-the-year walleye and yellow perch in four lakes in Voyageurs National Park" in the *North American Journal of Fisheries Management* 7: 513-521. Copies of the reports and paper are available from the park.

These study results are being used by the park and other recognized water users in an attempt to develop a water regulatory system that is both more environmentally and socially acceptable. When a consensus for a preferred alternative is reached among the various water users, it will be presented to the International Joint Commission (IJC), which must authorize any changes since it has jurisdiction over water levels in the major lakes in Voyageurs NP.

* * *

"The Stratigraphy and Development of a Floating Peatland, Pinhook Bog, Indiana," are explored by Douglas A. Wilcox and Howard A. Simonin of Indiana Dunes National Lakeshore in Volume 8 (75-91) of *Wetlands*. The article suggests some of the factors responsible for mat development – part of the process causing formation of peatlands. The paper presents stratigraphic data, formulates the developmental history of the peatland

Regional Highlights

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and its floating mat (or *schwingmoor*), and compares this information with that published for other floating peatlands.

* * *

Another paper co-authored by Doug Wilcox, "A Paleoecological Test of a Classical Hydrosere in the Lake Michigan Dunes," appeared in *Ecology* (Vol. 69, No. 4, pp. 928-936), describing varied aquatic vegetation along a chronosequence of dune ponds at Miller Woods, Indiana Dunes National Lakeshore.

Wilcox's papers from the 1986 George Wright science conference in Fort Collins, Colo., have been published as a hard cover book by Michigan State University Press under the title *Interdisciplinary Approaches to Freshwater Wetlands Research*.

North Atlantic Region

At the George Wright Society meeting in Tucson, Ariz., in November the North Atlantic Region convened a meeting of NPS scientists, managers and resource managers to discuss problems of white-tailed deer management. We are organizing a more formal workshop to discuss current and imminent management activities. Those wishing to participate should contact Mike Soukup at (617) 565-8805 or FTS 835-8805.

* * *

Over the past several months the North Atlantic Region has watched a number of our natural resource managers move around the Region and the Service. We were sorry to see Barbara Samora move on to higher pastures from Cape Cod NS to Mount Rainier NP. However, Cape Cod acquired Dave Manski from Wrangell-St. Elias NM in Alaska. The Regional Office lost Len Bobinchock to Acadia NP, where he assumes duties as Chief, Interpretation, Resource Management and Visitor Protection. And most recently we learned that Allan O'Connell will move from Fire Island NS to Acadia to take over Carroll Schell's position. Carroll has moved down to help out the National Capital Regional Office.

* * *

From Ray Kimpel at Sleeping Bear Dunes National Lakeshore comes word of the 14,500-acre North Manitou Island and its deer herd, which had eaten itself out of house and home. Sleeping Bear Dunes became responsible in 1984 for the island. With the authority and assistance of the Michigan Department of Natural Resources, special deer hunts were initiated to harvest as many of the deer as possible, until a normal vegetation pattern could be documented. Now, reproduction and young growth of highly edible plants is being observed generally throughout the island and in established monitoring plots.

Cooperation between the NPS and the Michigan DNR has been a crucial factor in the program's success. The herd, once numbering close to 1,800, is now estimated at 500. Each year between 400 and 700 hunters have made the trip to the island to take part in the hunt, despite difficult travel logistics caused by the early winter storm conditions. Hunter success rates have averaged between 22 and 116 percent. In 1982 North Manitou was designated for wilderness management until Congress could act on its designation under a separate wilderness bill. When the hunts were initiated in 1985 rangers encouraged the use of wilderness camping methods. It appears that there is a cadre of returning hunters who demonstrate a high respect for the wilderness aspects of this program. A primitive weapons hunt is tentatively planned for 1989. Max Holden or Al Haecker at Sleeping Bear can provide details to anyone wishing more information on this project.

meetings of interest

1989

January 16-20, FIRST CONFERENCE/ANNUAL MEETING OF SOCIETY FOR ECOLOGICAL RESTORATION AND MANAGEMENT (SERM), at The Claremont Resort Hotel, Oakland, CA; "Restoration: The New Management Challenge" is the theme. To be covered by William L. Halvorson, NPS research biologist at Channel Islands NP.

Feb. 1-3, RESEARCH NATURAL AREAS: ISSUES FOR MANAGERS workshop, at the Portland, Oregon Hilton Hotel; Contact Sherrie Reid, Bureau of Land Management, Oregon State Office, P.O. Box 2965, Portland, OR 97208. Some key questions: "How are RNAs chosen? Who takes care of them? How "natural" are they? What about fire, grazing, recreation, vandalism? Who conducts research and what kinds of studies are going on? How do RNAs affect adjoining lands and how do those lands affect the RNAs?"

March 20-23, NATIONAL ASSOCIATION OF STATE RECREATION PLANNERS' ANNUAL CONFERENCE; Charleston, SC; subject, "State Recreation Planning," Contact: Tony Bebbler, Planning Div., Dept. of Parks, Recreation and Tourism, 1205 Pendleton St., Columbia, SC 29201; (803) 734-0189.

March 29-31, OLD-GROWTH DOUGLAS-FIR FORESTS: WILDLIFE COMMUNITIES AND HABITAT RELATIONSHIPS; a symposium, at the Hilton Hotel, Portland, OR; contact Office of Continuing Education, College of Forest Resources, AR-10, U/WA, Seattle 09195.

April 14-16, THE AVANT-GARDE AND THE LANDSCAPE: CAN THEY BE RECONCILED? at U/Minn, Twin Cities campus. Contact: Landscape Conference, School of Architecture, U/Minn, 89 Church St. S.E., Minneapolis, MN 55455.

April 21, GLOBAL CLIMATE CHANGE AND NATURAL RESOURCE IMPLICATIONS FOR THE INTERMOUNTAIN WEST, at Utah State University, Logan, covering water resources, animal habitat, fire regime, rangeland and agriculture, and land management policy. Contact: Dean's Office, College of Natural Resources, U/St/U, Logan, UT 84322-5200 or (801) 750-2445.

May 18-20, RESTORATION AND PRESERVATION OF GREAT LAKES COASTAL ECOSYSTEMS, at Indiana Univ. Northwest, Gary, sponsored by Indiana Dunes National Lakeshore and Ill/Ind Sea Grant; chaired by Alan Mebane of Indiana Dunes NL, 1100 N. Mineral Springs Rd., Porter, IN 46304; (219) 926-7561.

May 30-June 2, INTERNATIONAL ASSOCIATION OF GREAT LAKES RESEARCH, 32nd Annual Conference; at Madison, WI, Contact: Dr. Gary Glass, EPA, 6201 Congden Blvd., Duluth, MN 55804; (218) 720-5526.

California Riparian Systems Conference Proceedings Due

"Protection, Restoration, and Management for the 1990s" was the title of the second in a series of California Riparian Systems conferences, held in late September 1988 at U/Cal, Davis, and attended by more than 800. Numerous familiar faces from the 1981 conference and many new ones as well, all reflected the enthusiasm for riparian concerns that continues to grow in the West.

Emphasis this time was on helping resource managers understand how these habitats function as systems, and on bringing people up to date on efforts in California and the West to restore riparian environments where they have been lost. Urban streams caught much attention, as did the protection and restoration of habitat for a number of threatened and endangered animals that live in the riparian zone.

Participants showed special interest in a session relating channel geomorphology to riparian conditions and in a pair of sessions dealing with the effects of diversion from mountain streams on riparian systems. Other sessions included managing riparian systems in forested lands and on rangeland streams and integrating public and private interests.

The NPS Rivers and Trails Technical Assistance Program in the Western Region was among the more than 20 conference sponsors.

About 100 of the papers will be published in the Proceedings, due in early 1989, in the General Technical Reports series of the Pacific Southwest Forest and

Range Experiment Station, USFS, Berkeley. Address requests for copies to Dana Abell, Technical Coordinator; Information Services Section, USFS-PSW, PO Box 245, Berkeley, CA 94701. The first printing will be distributed free. Riparian publications go fast, so an early request is recommended.

Dana Abell, Editor, *CRSC Newsletter*

Restorationists Meeting

Symposia on restoration in the national parks and on setting standards for the evaluation of restored ecological communities will highlight the first annual meeting of the Society for Ecological Restoration and Management, Jan. 16-20, 1989 in Oakland, Calif.

The meeting is the first major event for the recently formed, international society, and will be the first professional meeting for restorationists working with a wide range of ecological communities, according to meeting organizer John Rieger. The program will include papers, poster sessions and special lectures and workshops on subjects related to restoration and management.

Both symposium topics have been chosen because of mounting debate over the value of restoration as a way of solving environmental problems and maintaining natural and wilderness areas such as the national parks, Rieger said.

Further information and registration forms may be obtained from the Society's headquarters, 1207 Seminole Highway, Madison, WI 53711, (608) 263-7889.

Comprehensive Science Program Proposed for Alaska Region



National Parklands in Alaska

1. ANIACHAK
2. BERING LAND BRIDGE
3. CAPE KRUSENSTERN
4. DENALI
5. GATES OF THE ARCTIC
6. GLACIER BAY
7. KATMAI
8. KENAI FJORDS
9. KLONDIKE
10. KOBUK VALLEY
11. LAKE CLARK
12. NOATAK
13. SITKA
14. WRANGELL-ST. ELIAS
15. YUKON-CHARLEY RIVERS

Figure 1. Location of National Park Service Areas in Alaska. The areas are divided into parks, monuments, preserves, and wild/scenic rivers, totaling 23 units.

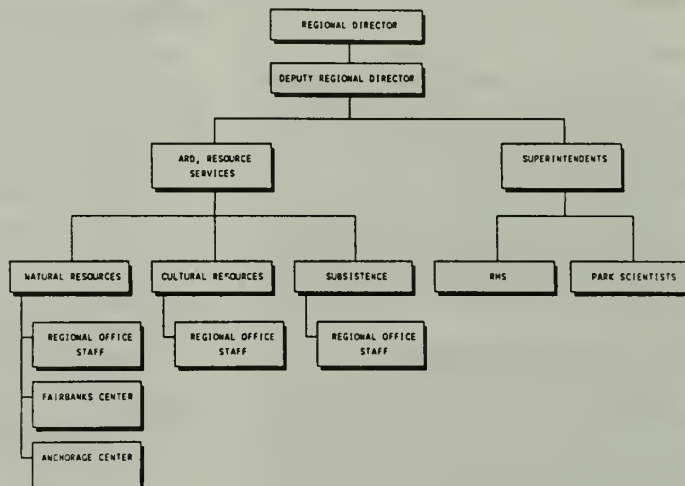


Figure 2. Organizational chart showing supervisory responsibilities. Science funding is managed through the Natural and Cultural Resource, and Subsistence Division Chiefs. Park scientists may be supervised either by Superintendents, Center Chiefs, or the Natural Resource Division Chief on a case-by-case basis.

By Dale Taylor, Allan Lovaas, and Ross Kavanagh

By passage of the Alaska National Interest Lands Conservation Act in 1980, Congress increased the number of National Park units in Alaska to 23, covering 53 million acres. These lands and resources are subjected to uses unprecedented in NPS history. The northern latitude of the parks makes them especially vulnerable to resource damage and their magnitude has allowed only cursory inventories. Preliminary Resource Management Plans and the Servicewide Natural Resources Assessment and Action Program listed needs for numerous research and resource management projects and managers are still identifying questions.

To meet the mandates for managing this huge area (Fig. 1), the Alaska Regional Director requested a plan that would, when funding is secured, ensure that administrative machinery is in place to operate a greatly expanded program for natural resources, cultural resources and subsistence research and management. Regional Director Boyd Evison stated:

"What will be proposed is going to be a 'roadmap' and rationale for the most fundamentally important undertaking to be engaged in by the Alaska Region of the NPS. It will put knowledge of park resources, and of their users, at the heart of all that we do in this region, to an extent far beyond anything ever contemplated by the Service at this level. It can be expected to devote a far larger percentage of positions and funds to those efforts, at the park and multi-park level, than are devoted to them anywhere else in the Service. The effects will be profound and far-reaching, on our ability to manage intelligently, on our perception of ourselves and our priorities as an organization, and on the way that others perceive us."

A team made up of NPS scientists, subsistence administrators and Superintendents recommended a preliminary plan (Fig. 2). The Cultural Resources Division of the Alaska Region supplied appropriate information and recommendations. The plan was then modified and enhanced according to comments from park Superintendents, the Regional Office, and a team of experts

from sister federal agencies, state agencies, universities, and the National Park Service.

An organization offering a balance between parks, research centers, and regional professional support was devised as the optimum structure for research and management in the Alaska Region (Fig. 3). To establish a "critical mass" of scientific expertise, and to reduce the total number of positions and housing costs, new Research Centers would be established at Anchorage and Fairbanks. A Cultural Resources Center is now in place in the Regional Office. Four distinct classifications of professional positions would be established:

1. **Natural and Cultural Resource Management Specialists** are professionals in the 100 or 400-series with probably full performance levels of GS-11 or 12. They should have achieved educational levels of Master's degrees or equivalent (e.g., NPS RM Trainee program) in the natural or cultural sciences, depending upon the position. These positions would be funded and supervised through the Park Superintendents (Fig. 3).

2. **Natural Research Scientists (Research Grade)**, with full performance level of GS-12/13/14, would be selected from the 400-series. They should have achieved educational levels of Ph.D., or equivalent.



Figure 3. The science team assembled to make recommendations for a comprehensive science program in the Alaska Region. Left to right: Al Lovaas (Chief Scientist, Alaska Region), Don Field (CPSU, Oregon State University), Dennis Fenn (CPSU, Texas A & M University), Dave Graber (SEKI), Dave Parsons (SEKI), Dick Martin (Superintendent WRST), Lou Waller (Subsistence Chief, Alaska Region), Gary Davis (CHIS), David Mills (Alaska Department of Fish and Game; now NPS Northwest Areas), Boyd Evison (Regional Director, Alaska Region).

These positions would be supervised through a Research Center Administrator, Natural Resources Division Chief (who in Alaska is also the Regional Chief Scientist), or Superintendent, depending upon the assignment (Fig. 3). The organization would be reviewed on an annual basis, and the Regional Director could change the supervisory level at his discretion. The positions would be funded through the Chief, Division of Natural Resources. Subsistence and Cultural Resource positions, not presently under research grade or research grants grade evaluation, are described in classification four below.

3. Natural Resource Administrators (Research Grants Grade) are Regional Office and Research Center Chiefs with Ph.D.s or equivalents and strong backgrounds in natural sciences research or administration. Full performance levels are usually GS-12/13 and 13/14 for administrators, depending upon the results of research grants grade evaluation. The positions would be supervised and funded through the Chief, Division of Natural Resources (Fig. 3).

4. Professional/Administrator are professional staff, administrators or subject matter specialists in the Regional Office Natural Resource or Subsistence Divisions, or Cultural Resources Center (Fig. 3). Individuals may be selected from the 025, 100, 400, or other series, depending upon the position descriptions. Full performance level would usually be GS-12 with some administrator positions grading GS-13.

In addition, support staff would include biological and cultural technicians, administrative clerks, clerk typists, budget and voucher examiners, and specialists in personnel management, contracting, and procurement. The positions grade from GS-4 through GS-11 and would be assigned at various levels within the Regional organization.

The present complement of scientists, resource managers, and cultural and subsistence specialists in the Alaska Region totals 24 permanent positions. Currently, two research wildlife biologists serve the 53 million acres, one resources management specialist for each 3.1 million acres, and one research ecologist, one management biologist (fisheries), and two full time subsistence specialists for the entire region. The Cultural Resources Center staff is nearly complete, with 13 positions filled, but funding for research projects and other cultural resource activities is inadequate.

If the proposed Alaska Region science program reaches full implementation, 134 new positions would be added, 41 new scientists, 33 new resource management specialists, and 60 new support positions. These numbers were reached by examining the resource needs in each of the 23 Units as expressed by Superintendents and Resource Management Specialists, mandates in the Alaska National Interest Lands Conservation Act, projects in resource management plans, and were refined through review by professionals in the advisory process.

Full implementation would result in 50 resource management positions in parks, 10 scientists in parks, 20 natural scientists in Research Centers, and 35 scientists/administrators (natural, subsistence, and cultural) in the Regional Office.

At present, most natural science research is accomplished by cooperative projects with the outstanding scientists available in the Alaska Department of Fish and Game, University of Alaska, U.S. Fish and Wildlife Service, U.S. Forest Service, and National Marine Fisheries Service. Even with a major expansion, the NPS never will be able to conduct all necessary research in-house, and will continue to rely heavily on these cooperative ventures.

mab notes

The U.S. MAB Directorate on Biosphere Reserves met Oct. 19, 1988. News from this meeting included the following items.

Biosphere Reserve Proposals. The Directorate urged early transmittal of the nomination of the Central California Coast BR to UNESCO for review in November. This reserve would consist of coastal/marine portions of Farallon Islands National Wildlife Refuge, Golden Gate National Recreation Area, Gulf of the Farallones National Marine Sanctuary, Point Reyes National Seashore, as well as several state parks and the Marin Municipal Water District. Transmittal of nomination materials to UNESCO was also endorsed to (1) link the Great Smoky Mountains NP, Coweeta Hydrologic Laboratory, and Oak Ridge National Environmental Research Park to form the Southern Appalachian BR, and (2) delete the Pinelands National Reserve from the South Atlantic Coastal Plain BR and redesignate the area independently as the New Jersey Pinelands BR. Nomination of a very large biosphere reserve encompassing the Adirondack Mountains and the Lake Champlain basin is being prepared by officials in New York and Vermont and is expected to be forwarded to MAB in early 1989. Other biosphere reserve proposals that are moving ahead include the Ozark Highlands (feasibility study), Tennessee and Cumberland Valleys (development of nomination), and the Mammoth Cave area (development of nomination).

U.S.-Soviet Bilateral Research. *Glasnost* seems to be extending to international scientific cooperation. Stan Krugman (USFS), Bruce Wiersma (EGG-Idaho), and Ray Herrmann (NPS) visited the Soviet Union to develop a preliminary work plan for bilateral research in biosphere reserves, under Section 5 of the 1972 U.S.-U.S.S.R. Environmental Agreement. Their discussions, described as remarkably open and wide-ranging, focused on collaborative research in biosphere reserves and related ecological research sites in the tundra-boreal forest ecosystems of northwest Alaska and northeastern Siberia, the northern hardwood forests of the northern midwest and the region around Moscow, and the temperate deciduous forests of the Southern Appalachians and the Caucasus. Data exchange will begin immediately, and comparative field studies are proposed to begin in the summer of 1989.

U.S.-China Bilateral Research. A U.S.-China bilat-

eral program in ecological research and modelling has been running for one year. U.S. scientists from various institutions are collaborating with colleagues at the Shenyang Institute of Applied Ecology on temperate forest studies and with the South China Institute of Botany on a program involving subtropical and tropical forests. Under the temperate forest program, a U.S. scientist lectured in China and assisted Chinese colleagues with modelling methodologies; two Chinese scholars were scheduled for an extended visit to the University of Virginia in late 1988. The second program focuses on developing the knowledge and skills for managing and rehabilitating subtropical and tropical forests.

Smithsonian/MAB Biodiversity Program. This highly successful program, which provides training in inventory and monitoring methods for workers in developing countries, has held workshops during the past year in Puerto Rico, Peru, and Bolivia. The scope is expanding to include management of biosphere reserves. Students at a workshop at Bolivia's Beni BR worked with local people to develop ideas for a Beni management plan. India and China are among the possibilities for near-term expansion of the program.

FY1989 Research Proposals. Participating agencies have thus far pledged \$750,000 toward the \$1 million goal for research in FY1989. Preproposals are being reviewed by the appropriate directorates and their recommendations forwarded to the MAB Executive Committee. The MAB-8 Directorate will give priority to proposals relating to regional or global influences affecting ecosystem processes and/or biological diversity in biosphere reserves, and those that relate biological diversity to ecosystem management.

Napier Shelton
NPS, WASO

NR Management Highlights

Highlights of Natural Resources Management: 1987 is the second annual look at the NPS research program and related resource management activities compiled by Donna O'Leary, publications coordinator/editor with the NPS Air Quality Division, P.O. Box 25287, Denver, CO 80225-0287; (303) 969-2156.

The 55-page report is an illustrated GPO publication divided into five sections: threatened and endangered species, research and technology, inventory and monitoring, cooperative research, and resource initiatives and programs.

present budget would place Alaska only in the mid-range of servicewide regional research and resources management capabilities.

The information base developed through the proposal would have value far beyond park boundaries. In addition, with new employees, jobs would be created in the private sector in communities ranging in size from Anchorage to Port Alsworth.

A frequent comment by reviewers was that the proposal, if anything, is too modest for the job that needs to be done. Although ambitious, far reaching, even evolutionary, we realize the plan still will not produce programs in parity with those of the major natural resource rich lower-48 state Regions. But, we maintain, once gains are consolidated into the next century, new visions will be forthcoming.

Taylor is a Wildlife Research Biologist, Lovaas the Regional Chief Scientist, and Kavanagh the Fishery Management Biologist in the Alaska Regional Office.

Otters, Fire, and the Ocean: An Unusual Relationship at Acadia

By Leslie J. Dubuc, Ray B. Owen, Jr.,
William B. Krohn, and Carroll J. Schell

Little was known until recently about the population status of river otter in Acadia National Park (ACAD) and the influence of trapping outside of the park's boundaries on this secretive species. In 1985, we began a study to determine the distribution, food habits, and habitat relationships of otters on Mount Desert Island (MDI), Maine. The purpose was to provide information for managing otters.

Otter sign (scats, latrines, tracks, and glides) was searched for during two summer and two winter field seasons on MDI's 39 watersheds. Otter scats were collected and analyzed for prey items. Data also were collected in each watershed on stream gradient and flow, riparian vegetation, wetland characteristics, and beaver activity.

Our results were somewhat unexpected! Many watersheds on MDI are short (<5km), have steep gradients with rapid runoff, and are relatively infertile. Few permanent, non-manipulated wetlands exist and otter habitat appears marginal. However, two factors offset this initial impression of habitat suitability. First, the ocean, a food rich habitat, is readily accessible via the many streams on the island. During summer, amphibians were the predominant food item (65% occurrence) of otters, but in winter, fish (85% occurrence) were present most often, and of the fish, marine species were most common. Snow tracking revealed otters using streams as small as 1.5 m in width to access the marine environment, and we often observed otter slides on cobble and sand beaches.

The other major factor influencing otter habitat on MDI was the 1947 fire that burned more than 6,000 ha, including much of the eastern portion of ACAD. Climax spruce-fir forests were replaced by aspen, birch, and other deciduous species. Beaver numbers increased rapidly and modified the watersheds in the burned area,

greatly increasing the number and area of wetlands. Beaver-created wetlands provided stable water levels year-round, thus improving habitat for important prey items such as fish and amphibians. Also, abandoned beaver lodges and dams provided excellent denning and resting sites for otters. When we mapped the distribution of otter on MDI and ACAD, there was a strong correlation with watersheds that contained beaver; the beavers' presence, in turn, was correlated with the distribution of aspen resulting from the fire (Fig. 1).

Prior to 1947, otter densities on MDI were probably low, approximating the present situation on the western side of the island where watersheds are dominated by spruce-fir and few wetlands occur. Easy access to the ocean, with its rich food supply, greatly enhances the ability of otters to remain in this region. Although the 1947 fire was catastrophic, it did increase habitat diversity on the eastern half of the island. Beaver responded to the aspen food supply and, through their modification of watersheds, have benefited not only otter but a variety of other wetland species. With the tremendous influx of people to ACAD each summer, otters apparently withdraw to more inaccessible wetlands. In winter they readily move between fresh water and marine environments and thus have the best of two "worlds."

The aspen-birch forest will slowly revert to spruce-fir, and eventually beaver and otter populations will decline. Only large scale habitat management can reverse this trend, but activities such as this are not appropriate in the park. Currently trapping on MDI does not seem to have a major effect on the otter population in ACAD. On average, four otter are harvested on MDI each year outside of the park, and most are taken incidental to beaver trapping. The research report to Supt. Jack Hauptman recommends that beaver and otter populations should be monitored every five years and that trapping should be restricted on MDI if the surveys show

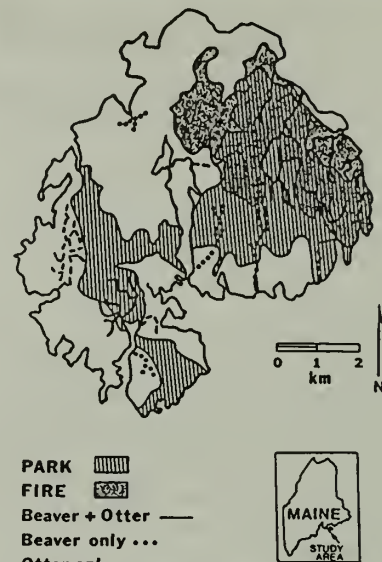


Figure 1. Location of Acadia NP, 1947 fire, and watersheds regularly used by otter and beaver on Mount Desert Island, Maine.

these populations to be seriously declining. Further, because of substantial development pressure being experienced on the island, riparian buffer zones should be established and maintained along streams used by otters for access to and from the ocean. Finally, public access to the fresh water wetlands used extensively by otter should remain limited.

Dubuc and Owen are with the Wildlife Department, University of Maine, Orono. Krohn is Leader of the U.S. Fish and Wildlife Service's Maine Cooperative Fish and Wildlife Research Unit in Orono, and Schell is Chief of Resource Management at Acadia NP. (Dubuc is now with Normandeau Associates in Bedford, N.H., and Schell with the NPS National Capitol Region.)



Wetlands such as the one shown here under Beehive Mountain at Acadia NP's Mount Desert Island are indicative of the complex interrelationship among fire, plant communities, beaver, and river otter. Fire creates the conditions for aspen growth, which attract beavers, which build dams, which create wetland conditions favorable to the otter.



Beaver dams such as this one at Mount Desert Island in Acadia NP are important factors in establishing habitat for a variety of wildlife including river otter. Beaver-created or modified wetlands support an abundance of fishes and frogs, major items in the otter's diet, as well as providing isolation and safe resting places.

Biotic Integrity Index Aids Aquatic Inventories

By Nancy Hoefs

Management for preservation of the biological integrity of aquatic natural resources of National Parks and Riverways, a goal of the NPS Resource Inventories and Monitoring Program, should be based on ecological evaluation that integrates physical, chemical, and biological variables. The biological integrity of an aquatic ecosystem is its ability to support and maintain a "balanced integrated adaptive community of organisms having species composition, diversity, and functional organization comparable to that of natural habitat of the region." (Karr and Dudley 1981).

The physical and chemical characteristics of natural waters are routinely monitored; direct biological monitoring of aquatic communities is less frequent. As a result, decisions in environmental management too often are based on water quality data rather than biological integrity. Many human impacts such as intermittent additions of contaminants, habitat alteration, reduced or altered energy flow through the system that degrades aquatic communities, are not always detected by physical and chemical monitoring. With increased use and development surrounding National Scenic Riverways and Parks, degradation of aquatic resources due to human impacts will become more of a problem. Protection of natural resources has been guided primarily by a focus on water quality monitoring. Direct monitoring of biological communities into resource management decisions is also needed to assure the integrity of these resources.

As indicators of biological integrity, fish communities have several advantages. Fish integrate the effects of watershed degradation, are typically present in all but the most ephemeral or polluted aquatic habitats, are comparatively easy to identify, and include a range of species representing a variety of trophic levels. Because fish are dependent on habitat and the biotic components (e.g. macroinvertebrates) of the ecosystem for survival and growth, they integrate the effects of complex and varied impacts affecting other components of the ecosystem. Thus, they reflect the direct and indirect effects of environmental stresses on the entire aquatic ecosystem (Karr 1981).

The Index of Biotic Integrity (IBI; Karr 1981) directly assesses the biological integrity of aquatic ecosystems by measuring a range of fish community attributes that reflect the prevailing chemical, physical, and biological conditions of the aquatic environment. Changes in species richness and composition, trophic composition, and other such factors are directly influenced by water quality disturbances and/or man-induced habitat alterations. As a management tool, the IBI measures the overall effects of environmental degradation.

Although fish communities are sampled routinely by state and federal agencies, tools for analysis and interpretation of the data gathered have been insufficient. As a result, these data are not incorporated into management decisions. The strength of the IBI is its ability to assemble information from individual, population, and community data into a single ecologically based index of biotic integrity. Along with information on physical and chemical conditions, the IBI can provide a sound basis for management evaluations and decisions.

The IBI consists of 3 categories of 12 fish community metrics (Table 1) (Karr et al. 1986). Individually, each metric provides information about a specific attribute of the aquatic resource; together, they characterize the underlying biological integrity of that site. The first category assesses species richness and composition: the total number of species, the number of intolerant species, and species in 3 major families of insectivorous

Table 1. Metrics used to assess fish communities (after Karr et al. 1986).

Category	Metric	Scoring criteria ^a		
		5	3	1
Species richness and composition	1. Total number of fish species	Expectations for metrics 1-5 vary with stream size and region		
	2. Number and identity of darter species			
	3. Number and identity of sunfish species			
	4. Number and identity of sucker species			
	5. Number and identity of intolerant species			
	6. Proportion of individuals as green sunfish	<5%	5-20%	>20%
Trophic composition	7. Proportion of individuals as omnivores	<20%	20-45%	>45%
	8. Proportion of individuals as insectivores	>45%	45-20%	<20%
	9. Proportion of individuals as piscivores (top carnivores)	>5%	5-1%	<1%
Fish abundance and condition	10. Number of individuals in sample	Expectations for metric 10 vary with stream size and other factors		
	11. Proportion of individuals as hybrids			
	12. Proportion of individuals with disease, tumors, fin damage, and skeletal anomalies	0%	>0-1%	>1%
		0-2%	>2-5%	>5%

^aRatings of 5, 3, and 1 are assigned to each metric according to whether its value approximates, deviates somewhat from, or deviates strongly from the value expected at a comparable site that is relatively undisturbed.

fish. Suckers and darters feed predominantly on benthic invertebrates; sunfish feed primarily on midwater and surface invertebrates. The sensitivity of these groups to degradation of their food sources and habitat make them ideal indicator species. Also the total number of species, the percent intolerant species, and the percent green sunfish (a tolerant species), will be altered with increasing environmental degradation.

The energy base and trophic dynamics of the fish community are assessed in the second category by classifying individual species as omnivores, insectivores or piscivores. The trophic structure of the community can provide information concerning alteration in water quality or other habitat changes, including land use patterns that result in changes in the fish community.

The final category evaluates the quality of fish populations by examining abundance, proportion of hybrids, and physical condition (i.e. the proportion of individuals with disease, tumors, fin damage, and anomalies).

The value of each metric is compared to the value expected from a relatively undisturbed system. Ratings of 5, 3, and 1 are assigned to each metric according to whether its value is what would be expected, moderates slightly, or deviates strongly from the value at a relatively undisturbed site. Criteria for species richness and the composition metrics are set using maximum species richness lines, which describe changes in the number of fish species as a function of stream size. The site is then assigned to an integrity class (ranging from excellent to very poor) based on the total of the 12 metric ratings (Karr et al. 1986).

Many of the metrics and their scoring criteria can be adapted to ecological regions where the structure and function of the fish communities differ. For example Fausch (1986) modified the IBI for use in the St. Croix National Scenic Riverway by changing several community attributes to make the index more sensitive to environmental alterations. The modified IBI was used to screen a large number of sites and identify those that appeared degraded. Recommendations were made about sampling site choice and methods for future bio-monitoring in the Riverway.

We are currently assessing the IBI for applicability to resource inventory on the two principal rivers (Current

and Jacks Fork) within the Ozarks National Scenic Riverways, using diverse data collected over the last 50 years by the NPS and the Missouri Department of Conservation. Index metrics are being modified to respond to changes in land use practices that may affect the biological integrity of the Riverways. Changes incorporate the unique ecological attributes of the fish communities that have evolved in the karst spring fed rivers of the Ozark ecoregion. Once adapted for the Ozarks, the IBI can be used to screen existing data and provide a working model for use in management decisions.

The potential of the IBI as a tool in resource inventory and monitoring of other NPS river systems appears promising. Plans to apply the IBI to aquatic resource inventory are being considered in several prairie parks in Missouri and Nebraska, including Wilson's Creek and Agate Fossil Beds.

The periodic chemical and physical analysis currently being used for nonpoint source pollution that may indicate degradation may be less sensitive than necessary for adequate protection of the aquatic resource, particularly in view of increasing arrays of impacts within the watersheds of many of these areas. Incorporation of resource inventory, biological monitoring, and suitable indices such as the IBI will provide management with a direct measure of biological integrity.

Hoefs is a biologist with Colorado State University and a cooperater with the NPS Water Resources Division in Fort Collins, CO.

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The 1988 Yellowstone Fires: Preliminary Report

By Paul Schullery

The fires that burned large portions of the Greater Yellowstone Area (GYA) in the summer of 1988 are being called the most significant ecological event in the history of the national parks. They are also being called the result of the largest fire suppression effort in history. They have generated enormous media attention, substantial political controversy, intense scientific interest, and a remarkable outpouring of public concern. It is too soon to judge the effects of all this attention on the park and on NPS and USFS policy, but the fires have now been studied enough that at least a preliminary summary of their scope and ecological effects can be made.

Over the past 30 years, several NPS areas have cautiously embraced one form of prescribed burning or another, in recognition of fire's important role in the natural processes of a wilderness setting. Everglades NP began using prescribed (man-set) fires in 1958, and in 1964 study plots were first burned in Sequoia and Kings Canyon NPs. The first natural fires to be permitted to burn also occurred in Sequoia and Kings Canyon, in 1968. By 1978, 12 areas in the national park system had natural fire zones. In 1972, Yellowstone initiated its Fire Management Plan by designating 340,000 acres as appropriate for natural fires. Over the next several years, and after an Environmental Assessment in 1976, more than 1,700,000 acres in Yellowstone were included within natural fire zones, and cooperative agreements were reached with surrounding national forests to allow natural fires to burn across certain administrative boundaries.

In the first 16 years of Yellowstone's program (1972-1987), many thousand lightning strikes occurred, but few burned any acreage. In all, 235 fires burned a total of 34,157 acres. The largest fire burned 7,400 acres, but most burned only a few acres. It became clear that only in extremely dry years will natural fires grow large in Yellowstone.

1988 was an extremely dry year. Though April and May experienced 155 and 181 percent of normal precipitation respectively, June rainfall was 20 percent of normal, July was 79 percent of normal, and August was only 10 percent of normal. The six previous Julys (1982-1987) had averaged more than 200 percent of normal, a pattern that fire experts tried to anticipate in determining when it was necessary to suppress 1988 fires.

May and June natural fires behaved as fires had in past years: 11 went out on their own accord, and the rest showed no unusual behavior until well into July, when it became clear that the July rains experienced in previous years would not be repeated in 1988. After July 15, no new natural fires were allowed to burn unfought; after July 21, all fires were subjected to as full a suppression effort as available personnel and equipment would permit. As of that day, less than 17,000 acres were within the perimeters of existing fires.

An interagency fire fighting effort was initiated that eventually involved fire experts from all parts of the country, as many as 9,500 fire fighters working in the GYA at one time (and a total of 25,000 over the course of the summer), dozens of helicopters, more than 100 fire engines, and a cost of about 112 million dollars. On November 12, though the entire park was covered with snow, a few minor smokes persisted here and there.

Firefighters encountered conditions and fire behavior that most had never seen before. High winds caused fires to move with unusual speed, and made traditional fire fighting methods useless, even dangerous. Fire line

"Lessons from the Flames" is the title of the two-part series by Richard Monastersky in the Nov. 12 and 19, 1988 issues of *Science News* – the story of the Yellowstone fires as gleaned from NPS and other scientists. In an associated story in the Nov. 12 issue, Monastersky looks at NPS fire policy. In "Taking the Heat: A policy under fire," John Varley, head of Yellowstone research, is quoted as saying "Of course we're going to revise our policy. We just took a giant step forward in understanding fire behavior. That policy has evolved. It's not the same kind of dogma we adopted in 1972."

One of the fire chiefs in the park this year is quoted also: "There's going to be a new chapter in the fire behavior books ... and it's going to be a long chapter."

construction regularly proved ineffective, because wind-driven embers as much as two miles ahead of the main fire were creating hundreds of small "spot fires." Thus it was impossible to put fire crews directly in front of big fires because they might be caught between the main fire and its outlying spot fires. Fires would run 5 to 10 miles in a day, and then, because of unusually low humidity, would not "lie down" at night as fires most often do. Fires routinely jumped major topographical barriers, including the Grand Canyon of the Yellowstone River.

Aerial reconnaissance surveys conducted with infrared photography in September gave managers their first scientific estimates of burn acreages in the GYA. These were maximum estimates based on fairly coarse resolution 1:63,360 maps (smallest map unit – 200 acres); later mapping this winter and next summer will refine the numbers. A total of 1.38 million acres in the GYA experienced some sort of burning. Within Yellowstone Park, 995,000 acres were burned. Of that, 573,000 acres were canopy burn, 367,000 acres were surface burn (most trees over this surface burn will not die), and 55,000 acres of meadows and sage/grass-

An approximately hour-long videotape entitled "The 1988 Yellowstone Fires" is being prepared by Video Visions of Bozeman, Mont., in cooperation with scientists and resource managers who were involved with managing the Yellowstone fires. At press time the script was still undergoing last minute changes, but the tape was scheduled for completion by early spring. It can be ordered from Video Visions, P.O. Box 6721, Bozeman, MT 59715, for \$24.95, which includes shipping costs.

lands burned. This means that roughly one-quarter of Yellowstone will still be blackened by next June when visitors begin to arrive in numbers.

Considering the speed of some fires, losses of large mammals in the park were light. As of November 1, upon completion of an extended air and ground survey, 243 elk (less than 1 percent of the GYA's summering population of 32,000), 5 bison, 4 deer, 2 moose, and various smaller animals were reported killed, practically all by asphyxiation. Losses in surrounding national forests were similarly light. No threatened or endangered animals have been reported lost. Animals were routinely able to move aside when fires passed, and were caught only in extreme conditions of fast-moving fires.

This winter's controversies include numerous questions: Deciding whether or not to feed any animals due to burning of winter range; examining the timetables of suppression decisions; considering if and where reseeding should be done in the park; and evaluating the countless day-to-day decisions of the interagency fire fighting teams and the relations between the various agencies involved, whose philosophies of land management often differ. Any of these topics would require an article of its own even at this early stage.

Media attention caused enormous public confusion. All fires were routinely reported as "Yellowstone fires," and ascribed to the park's natural fire management plan (routinely misidentified as the "let-burn policy") when at least half of the acreage burned in the park was burned by man-caused or natural fires originating on national forest lands outside the park. All park developments except Grant Village, and all surrounding communities that were at any time threatened by fire were in fact threatened by man-caused fires not associated with the park's fire policy. Media reports consistently used fire perimeter acreages as actual burn acreages, though USFS and NPS daily reports cautioned that much land was unburned within perimeters. This misreporting gave the public an inflated idea of total burn acreage.

A detailed report, entitled *The Yellowstone Fires: A Primer on the 1988 Fire Season*, is available from the Superintendent, Yellowstone National Park, Wyoming, 82190.

Schullery is a Technical Writer at Yellowstone NP.

Cal Parks Science Conference Draws 130

The response in attendance (more than 130) and paper and poster presentations (more than 75) at the third Biennial Conference on Research in California's National Parks at U/Cal Davis in September 1988, caused CPSU Director Stephen Veirs to observe:

"The primary goals for the conference are technology transfer between park scientists and resource managers and an increased understanding of park ecosystems. It looks very much as though conferences such as this one are instrumental in achieving these goals."

Plenary addresses included "Perspectives on Current and Future Research in the National Park Service" by Eugene Hester, Associate Director, Natural Resources (WASO); "A View From the National Parks and Conservation Association on Research in the National Parks" by Douglas Latimer, Gaia Associates; "A Longer View: Vegetation Change over 11,000 years in Sierran Montane and Subalpine Forests" by R. Scott Anderson, Assistant Research Professor, Bilby Research Center, Northern Arizona University; "The Resource Manager and Researcher as a Team" by Frank Ugolini, Resource Management Specialist, Channel Islands NP; "Statistical Pitfalls for Field Studies" by Neil Willits, Statistical Consultant, Statistics Department, UC Davis; "The Modern Biological Surveys, its Resource Inventory and Monitoring Role in National Parks" by David M. Graber, Research Scientist, Sequoia and Kings Canyon NP; and, "The Giant Sequoia Fire Controversy: A Case Study of the Role of Science in Natural Ecosystem Management" by David J. Parsons, Research Scientist, Sequoia and Kings Canyon NPs.

A proceedings of selected papers is in the works; meanwhile, copies of the abstracts will be available while supplies last from Silvia Hillyer, CPSU/Environmental Studies, U/Cal, Davis, CA 95616.

Thomas J. Stohlgren, Ecologist
NPS/CPSU, U/Cal, Davis

Prescribed Fire Review Sparks Studies of Giant Sequoia-Fire Interactions

By David J. Parsons

Challenges to the goals and methods for prescribed burning in the giant sequoia groves of Sequoia, Kings Canyon (SEKI) and Yosemite NPs have led to a major research program on fire and vegetation history, fire effects, fire and fuel modeling, and visitor perceptions of fire. The studies are in direct response to recommendations made in a 1987 report evaluating the use of prescribed fire in those areas.

In 1986 the NPS Western Regional Office appointed an independent panel to review the status of the prescribed fire management program for the sequoia mixed-conifer forests of the Sierran NPs. Despite nearly two decades of using prescribed fire as a tool to reduce fuels accumulated during most of a century of fire suppression, many questions remained unanswered. The use of fire to create a desired effect had advanced beyond the understanding of both historical fire regimes and fire effects. Similarly, the articulation of objectives and quantification of standards by which to evaluate progress were in need of review.

Specifically, questions had been raised regarding the impact of fire suppression on fuels and forest structure, the effects of burning at different intervals and intensities, and the relative merits of managing for natural ecological processes as opposed to visual or scenic values. The latter was brought to a head when several individuals criticized the objectives of preserving ecosystem processes as compromising the protection of the giant trees for which the Sierran parks had been created. Concern was expressed that the black bark char on specimen sequoias and foliage scorch of understory trees resulting from prescribed burns were not acceptable.

The review panel appointed by the Western Regional Office included experts in vegetation and fire ecology (including specific familiarity with giant sequoia or other Sierran conifer forest types), visual resource management, and NPS policy. Individuals who had been actively involved in the development, implementation or critique of the prescribed fire program were not included on the panel. Dr. Norm Christensen, Professor of Botany at Duke University and Chairman of the Vegetation Section of the Ecological Society of America, was named panel chairman. The 7-member panel was also asked to evaluate the scientific basis for the program.

The final panel report was presented to Director Mott by Dr. Christensen in February of 1987. Along with recommendations on policy, objectives, implementation methods, monitoring and interpretation, the report identified a number of areas in need of additional study: The need for research on fire and vegetation history, life history and demography of giant sequoia and associated conifers, fuel dynamics, population and fire behavior models, user response to the burn program, and the effects of fire on pathogens, nutrient cycling, understory vegetation and fauna.

The panel felt that much basic information critical to the long term restoration of natural fire regimes was still lacking. The report, including the recommendations for additional research, was given wide coverage in the political, conservation and press arenas.

Following the attention given to the sequoia fire issue, the NPS has developed a multi-faceted research program. A combination of Washington, Regional Office and park funds, together with Forest Service and private support, has been used to address the majority of identified needs. Data being collected are expected to provide

the basis for standards to evaluate effectiveness of the prescribed fire program, both in reversing the impacts of fire suppression and in restoring a semblance of the historical fire regime. The research is a product of joint planning by Yosemite and Sequoia-Kings Canyon. Major studies undertaken to date are:

1) **Biogeography and Disturbance History of Sequoiadendron.** Dr. R. Scott Anderson (N. U/AZ) is using pollen and charcoal in meadow sediment cores to reconstruct 10,000 years of vegetation and fire history.

2) **Tree-ring Reconstruction of Giant Sequoia Fire History.** Dr. Tom Swetnam (U/AZ) is utilizing fire scars and cross-dating on sequoia stumps and logs to develop up to a 2,000 year fire history for selected groves.

3) **Age Structure of Giant Sequoia in Relation to Disturbance History.** This in-house project by David Parsons and Nate Stephenson (NPS-SEKI) investigates the effects of fire and climatic history on sequoia age structure and spatial patterning. It is closely coordinated with the previous two studies.

4) **Fuel Accumulation and Fire Modeling.** Dr. Jan van Wagtenonk (NPS-YOSE) is modeling fire and fuel dynamics in an effort to determine the natural range of fuel levels, number of prescribed fires necessary to bring fuel accumulations within that range, and intensities of those fires.

5) **Fire Effects on Forest Pathogens.** Dr. Doug Piirto (Cal Poly, San Luis Obispo) and Dr. J.R. Parmeter (UC Berkeley) are studying the effects of fire and fire suppression on pathogens associated with fire scars and roots as well as the cross-pathogenicity of decay organisms.

6) **Effects of Prescribed Fire on Forest Fuels and Soil and Cambium Temperatures.** Steve Sackett and Sally Haase (USFS Riverside Fire Lab) are studying nutrient cycling and temperature penetration in soil and cambium under different burning conditions.

7) **Conditions Influencing Seedling Establishment and Survival.** Stephanie Gebauer (Duke Univ.) is attempting to provide an understanding of the spatial heterogeneity of forest resources critical to conifer seedling establishment and survival.

8) **Visual Resource Management.** Dr. Kerry Dawson and Steve Greco (UC Davis) have applied principles of visual resource management to recommend that more heavily used areas be divided into relatively small units to prescribe burn on a rotating basis, thus assuring that park visitors are provided a full range of successional views.

9) **Visitor Perception of the Fire Management Program.** Dr. Joyce Quinn (Cal/State/U, Fresno) surveyed 1,000 park visitors to determine the understanding and level of support for the use of fire in giant sequoia management. The survey showed a high awareness and understanding of the prescribed fire program.

In addition to these major undertakings in direct response to the Christensen Report, a number of other studies are either underway or have been carried out in the past year relating the broad question of fire history and effects in the sequoia mixed-conifer forests of the Sierra Nevada. These include the use of micro-probe analysis to detect possible chemical signals of past fires in tree-rings, climate reconstruction from tree rings, Native American use of fire, size structure analysis of giant sequoia, fire induced mortality of conifers, impacts of fire suppression on forest aggregations, soil solution chemistry and nutrient cycling, ozone stress on conifers, and watershed biogeochemistry. Several additional

studies have been proposed for coming years.

Given a continuity of funding (already threatened due to budget restrictions) and opportunities to interact and apply the findings of these studies to the very real management problems of whether, when, where, how often and how hot to burn, this program has the potential to be one of the shining examples of applying science to everyday management challenges. The future promises clearer articulation of objectives and standards, which in turn, promises improved results in the struggle to preserve as near naturally functioning ecosystems as possible in this day of ever-increasing pressures from a modern technological society.

Parsons is a Research Scientist at Sequoia/Kings Canyon NPs.

Douglas-fir Old-Growth Posters Solicited

A symposium based on the results of research conducted by the USDA Forest Service Old-Growth Forest Wildlife Habitat Research program and cooperators will be held in Portland, Ore., March 29-31, 1989, based at the Portland Hilton hotel.

Scientific findings of wildlife and plant community studies conducted from 1983-86 in Douglas-fir forests of Washington, Oregon, and northern California will be presented. Patterns of vertebrate abundance, habitat use, and community structure will be reported from data collected in more than 150 stands occurring along an age gradient from young to old growth.

Posters are being solicited for related topics and will be presented at the Arlene Schnitzer Concert Hall in the Center for the Performing Arts. Poster abstracts will be published as part of the proceedings. Two copies of a 200-word abstract should be submitted by Jan. 31, 1989, to Dr. Mark Huff, USDA Forest Service, Forestry Sciences Lab, 3625 93rd Ave. S.W., Olympia, WA 98502; (206) 753-9494. Include title, all authors' names and affiliations, complete mailing addresses and telephone numbers.

Hawaii Book Covers Conservation Biology

Conservation Biology in Hawai'i, a collection of essays edited by Charles P. and Danielle B. Stone, is a 252-page book about Hawaii, by 32 authors, dedicated to recently deceased Hawaii Conservationist Wayne C. Gagne and to the premise that:

"Conservation biology is the combination of art and science, compromise and stubbornness, judgment and serendipity necessary to perpetuate some semblance of natural biological diversity on Planet Earth."

The book begins with Hawai'i's uniqueness, from origin to soils and biota, and describes in detail the plant and animal life — including alien plant and animal organisms and means for preserving and controlling the various species. Biological diversity and special communities, problems and planning, tourism, vegetation mapping, land use priorities, protection of natural habitats, and gene pool conservation are among the topics covered. Five essays look at conservation education — perspectives, history and problems, techniques and targets, classroom needs, and public media. Three essays on values and ethics wind up the volume.

The Stones, a husband/wife team, both work at Hawaii Volcanoes NP. Word from Research Scientist Chuck Stone is that the book will be on sale through the University of Hawaii Press by the time this issue of *Park Science* appears. Cost is \$16.

Caves, Bird Bones and Beetles: New Discoveries in Rain Forests of Haleakala

By A.C. Medeiros, L.L. Loope, and H.F. James

The Hawaiian Islands are noted for high levels of terrestrial biological diversity and local endemism (organisms found only in a particular area or region). Prior to arrival of humans, 95 percent of all flowering plants and 99 percent of insect species were endemic. The native birds of Hawaii such as the passerine honeycreepers (*Fringillidae: Drepanidinae*) are renowned as spectacular examples of adaptive radiation. However, by the time the first European naturalists arrived in the late 1700s, the Hawaiian avifauna was already declining rapidly. The extent of the loss of native Hawaiian bird species was not fully realized until the recent work of Smithsonian scientists Dr. Storrs Olson and Helen James. By exploring the sand dunes, sink holes, and lava tubes of the islands and collecting and examining bones found there, they have clarified not only the status of the Hawaiian bird fauna before the arrival of humans, but also the role that the first Polynesian colonizers, arriving in the 5th century, had in decimating that fauna (Olson and James 1982a, 1982b, 1984; James et al. 1987).

Field work by Olson and James in 1984 in a single cave at 305m elevation on ranch land had yielded sufficient bones for study to increase the known endemic land bird fauna of the island of Maui from 10 (the number known historically, of which 9 survive) to 29 species. Their field work during 1988 has yielded many additional undescribed species, some known from other islands and others only from Maui. Since all work on Maui to date by Olson and James had been in dry areas at low to middle elevations, the possibility of exploring caves in high-elevation rain forest appeared to offer potential for further finds.

Verdant, steep-walled Kipahulu Valley of Haleakala NP contains some of the least disturbed rain forest in the Hawaiian Islands. This valley is known for its diversity of endemic fauna and flora. Kipahulu and the adjoining upper northern slope of Haleakala volcano (including the state-owned Hanawi Natural Area Reserve and The Nature Conservancy's Waikamoi Preserve) are the last stronghold for many of Hawaii's remaining honeycreeper species. In 1984, a deep pit cave was discovered by park personnel in dense upper-elevation rain forest in Kipahulu Valley. Preliminary investigation of this cave was made by Dr. Frank Howarth, Paul Banko and Dr. Charles Stone. The initial results were extremely promising, revealing numerous sets of bones of bird species that did not survive into the historical period in Hawaii.

Later, park personnel discovered the entrance to a second cave that remained unexplored until this expedition.

Haleakala is an ancient shield volcano formed by lava flows starting about 800,000 years ago, but in modern times has remained quiescent (the last eruption occurred about 1790 on the SW flank). Massive erosion carved large steep-walled valleys 1000m deep in Haleakala volcano, especially on its northern and eastern flanks. Secondary eruptions from vents on the eastern rift flowed through some of these deep valleys, filling in their V-shaped bottoms (including Kipahulu).

Both Kipahulu caves are sections of lava tubes with collapsed "skylight" openings that connect them to the surface. Lava tubes are characteristic of fast moving pahoehoe lava flows where rivers of lava crust over at their surface while a central core of still molten lava continues its downhill course, but now underground. When the eruption finishes, these tubes are often emptied, forming long dome-roofed tunnels, which may in some instances extend for several kilometers.

On April 27-29, 1988, members of an interagency team headed by Helen James (Smithsonian Institution) and Frank Howarth (B.P. Bishop Museum of Honolulu) with an NPS support crew entered both caves, treated and removed bird bones, and made collections of cave invertebrates. The NPS group included Legario "Hanky" Eharis, Anne Marie La Rosa, Terrance Lind and Arthur Medeiros. The Kipahulu caves were given Hawaiian names by the expedition, the first as Luamanu (literally 'bird pit') and the second more recently discovered one as Pukamoa ('chicken-like bird hole').

The 10m wide entrance of Luamanu cave occurs on a forested ridge at 1830m (6000 ft) elevation with a vertical depth of 12m onto a mound of collapsed rock and mud. The lava tube continues only a few meters downslope but upslope extends 35-40m, forming a large dome-roofed room with an upward slope formed by large slabs of lava extending to the back of the room. Eighteen sets of bird bones of at least six species were collected, primarily in the rockfall of the large room.

The entrance of Pukamoa cave at 1860m (6100 ft) elevation is smaller and shallower yet the lava tube itself is comparatively extensive, extending 75m upslope and approximately 300-400m downslope. Three species (dark-rumped petrel, flightless ibis and flightless goose) were represented in the 16 sets of bones collected in this cave.

The Kipahulu lava tubes also yielded exciting finds of



Ranger Terry Lind with *Sadleria* and *Athyrium* ferns, *Broussasia*, and other native shrubs at the entrance to Luamanu cave, elevation 1830 m, in rain forest of upper Kipahulu Valley, Haleakala NP. (NPS photo by Anne Marie La Rosa)



Bones of an undescribed genus of flightless goose-like birds from a "pitfall" cave in upper Kipahulu Valley, Haleakala. (Photo by Helen James)

List of sub-fossil bird bones found in two lava tubes (Luamanu and Pukamoa), upper Kipahulu Valley, Haleakala National Park (HALE):

Family	Genus	Status
1) Procellariidae	<i>Pterodroma phaeopygia</i>	Endangered ¹
2) Plataleidae	<i>Apteribis</i> sp.	Extinct ²
3) Anatidae	<i>Branta</i> sp.	Extinct ³
4) Anatidae	undescribed genus	Extinct ⁴
5) Rallidae	<i>Porzana</i> sp.	Extinct ⁵
6) Fringillidae	aff. <i>Chloridops</i> sp.	Extinct ⁶

Footnote legend: 1) currently recognized as federal endangered species, has never been recorded nesting in Haleakala rain forests. 2) unrecorded until the 1970s when a species of this flightless ibis from Molokai was described, based on fossils. 3) similar to the extant nene (*B. sandwicensis*); the leg bones found in Kipahulu appear heavier and slouter and wing bones shorter, perhaps indicating reduced flight ability. 4) undescribed genus of flightless goose-like birds, to be described based on bone collections made in the 1980s. 5) cosmopolitan genus of rail in which all Hawaiian species are flightless; two Hawaiian species survived into the historical period, one species last seen in 1884 and the other in 1945; perhaps two species represented in Kipahulu material. 6) present only as a single associated set of bones found in Luamanu cave, this thick-billed honeycreeper is most similar to the Grosbeak finch found in the Kona district of Hawaii island, last seen around 1894.



Skull of an undescribed flightless ibis, *Apteribis* sp., from a "pitfall" cave in upper Kipahulu Valley, Haleakala. The tip of the bill has been broken so that about one-fourth of the bill's length is missing. (Photo by Helen James)



Expedition members (James, Lind, Medeiros, and Howarth) at the entrance to Pukamoa cave, elevation 1860 m, in Kipahulu Valley of Haleakala NP. *Metrosideros polymorpha* rain forest with fern understory in background. (NPS photo by Anne-Marie La Rosa)

living cave-adapted organisms. Each of the two lava tubes contains its own unique troglotic ground beetle (*Coleoptera: Carabidae*). Each of these carabid beetles is so distinctive in fact that Dr. Al Samuelson, B.P. Bishop Museum coleopterist, considers the beetle population of each cave to represent the sole species of its own endemic genus. An earthworm collection made in Pukamoa cave is a new family record for the Hawaiian Islands. Other arthropod species collected, including a millipede and collembola, await identification. Introduced rats, now common in Kipahulu Valley and found in both lava tubes, may threaten the long-term survival of some of these unique species.

Haleakala NP is an international Biosphere Reserve, recognized for unique and diverse ecosystems. As a protected refuge for otherwise threatened species, the remote reaches of the park in many cases provide the last chance for survival for many native Hawaiian organisms. The caves of upper Kipahulu represent one more example of the park's remarkable resources, some of which remain undiscovered and/or uninvestigated. The caves harbor the sole populations of unique living resources and provide an invaluable window into the

past through which we can glimpse some of Hawaii's former treasures.

Medeiros is a Research Assistant at Haleakala NP; James is a researcher at the National Museum of Natural History, Smithsonian Institution, Washington, D.C.; Loope is Research Biologist at Haleakala NP.

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book review

Bruce Hampton and David Cole. 1988. *Soft paths: how to enjoy the wilderness without harming it*. Stackpole Books, Cameron and Kelker Streets, P.O. Box 1831, Harrisburg, PS 17105, 173 p., \$10.95.

Dramatic increases in wildland recreational use have led many park and wilderness managers to pose the question: Are we literally "loving" our wilderness to death? The impacts to vegetation, water quality and wildlife associated with this use has prompted many managers to implement regulations which directly or indirectly restrict the freedoms of wildland visitors. The NPS, in particular, has more restrictive visitor regulations than the Forest Service, Bureau of Land Management, or Fish and Wildlife Service, as shown by a 1980 survey of wilderness managers.

The stated philosophy of this book is that most

damage stems not from malice, but from lack of visitors' awareness of the consequences of their actions. Furthermore, most backcountry visitors are anxious to do the right thing and need only to be taught the appropriate minimum impact practices and when to use them. A monumental task indeed, but this book provides a wealth of information, practices, and insights that define and provide the basis for a wildland ethic.

Soft Paths was sponsored by the National Outdoor Leadership School (NOLS), a private, nonprofit, educational corporation which offers wilderness skills and leadership courses. Bruce Hampton, senior staff instructor at NOLS, and Dr. David Cole, Research Biologist with the USFS Wilderness Research Unit, compiled and reevaluated the practices resulting from 23 years of NOLS backcountry experience. NOLS has long been a

recognized leader in the development and instruction of minimum impact camping practices. Cole, who has completed numerous recreational impact studies for NPS and USFS is a recognized authority on recreational impacts and their management.

The book describes the need for minimum impact practices, makes it clear that their adoption by backcountry visitors is critical, and acknowledges the complexity of the variables involved (soil, vegetation, wildlife, moisture, amount and types of uses, etc.)

The book covers backcountry travel, selecting and using a campsite, fires and stoves, and sanitation and waste disposal. The information in these chapters is organized and presented in separate sections relating to whether the visitor is in a core (moderate-heavy use) area of the backcountry or in a remote (low use) area.

Some information may strike some managers as inappropriate at first; e.g. innovative suggestions regarding appropriate methods for disposing of human waste in the backcountry. However, the scientific basis for the recommendations is given, in terms easily understood. An extensive bibliography of literature (primarily scientific) relating to minimum impact practices also is provided at the end of the book.

Particularly pleasing is the thorough treatment of minimum impact practices related to wildlife. The authors note that while the potential impact for each species varies, a general principle remains: respect their needs and minimize the disruption of their lives. (The authors also note the difficulties in applying this rule to mosquitoes).

The book also covers minimum impact practices in Special Environments, including separate chapters on deserts, rivers and lakes, coasts, alpine and arctic tundra, snow and ice, and bear country. Special environments imply special techniques. The authors caution that the basic practices presented in the first chapters may not be appropriate in all situations. What follows in these chapters are descriptions of these unique environments along with discussions of practices. Special topics commonly ignored in most minimum impact literature, such as travel in desert areas and across arctic tundra, are covered in considerable detail here.

Soft Paths is much more than a compilation of minimum impact practices. It differs from earlier works in its recognition and treatment of the complexity of this important topic. The wildland visitor is encouraged to exercise good judgment in applying knowledge and experience of minimum impact practices and the surrounding environment in efforts to reduce resource impacts. For rangers, resource managers, and interpreters with backcountry responsibilities this book is an invaluable reference. Many parks may wish to review and revise their existing backcountry regulations and minimum impact messages based on information in this book.

I would further suggest that the book would make an excellent addition on NPS visitor center shelves next to the trail guides and backcountry maps already being sold.

Jeffrey L. Marion, Ph.D.
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**Computer Corner
will appear in
the next issue.**

Biological Response to the Greenhouse Effect

A Conference Report
By Napier Shelton

An Everglades half under the sea. Spruce and fir disappearing from the Great Smokies and Nevada's Wheeler Peak. Tundra ponds becoming forest ponds in the lowlands of Denali. Such were the images conjured up for a Park Service person at the recent conference on Consequences of the Greenhouse Effect for Biological Diversity. Organized by the World Wildlife Fund-U.S. and co-sponsored by the National Park Service and five other organizations, it was held at the National Zoo auditorium in Washington, D.C. Oct. 4-6, 1988.

The conference brought together leading scientists to share their views on biological change under global warming. The picture they presented was complex and sobering. Major ecological dislocations were predicted, and, as the Chinese proverb quoted by George Woodwell goes: "If we continue to go in the direction we're headed, we're likely to get there."

The whole exercise, of course, was predicated on the truth of scientific consensus that rapid global warming, caused by increasing CO₂, methane, and other greenhouse gases in the atmosphere, will indeed happen in the next few decades. Stephen Schneider of the National Center for Atmospheric Research presented ranges of climate changes over the next 50 years or so from "state-of-the-art modeling results": a 2° to 5°C rise in global average annual temperature, a 7 to 15 percent increase in global precipitation, and a 10 to 100 cm rise in sea level. Regional changes, which carry more uncertainty, range from -3 to +10°C, and -20 to +20 percent for precipitation. Warming is expected to be much more pronounced in the temperate and, especially, high latitude zones than in the tropics. Such climatic changes will affect the timing and rates of snowmelt, the frequency of hurricanes and fire, nutrient cycles, oxidation of carbon stored in soil, and many other important environmental processes.

The extremely varied biological effects will be direct and indirect, and will be compounded synergistically by acid rain, stratospheric ozone depletion, deforestation, and other human-caused problems. Most major northern hemisphere plant communities are expected to shift northward and, on mountains, upward, with a reduced areal extent of tundra and boreal forest. Spread of boreal forests into tundra and increase of deciduous species in boreal forests has already been documented over the past 100 years, during which time summer temperatures in these regions of North America have increased by 2°C.

Potential range shifts of four northern hardwood species were investigated by Margaret Davis and Catherine Zabinski of the University of Minnesota. They compared geographical ranges of these species with maps of climatic variables to determine their temperature and moisture limits. Two models were used to generate scenarios of effects on species ranges. Both models predicted a displacement of more than 500 km for all four species. Sugar maple, which now ranges south to Tennessee, was predicted to become extinct in all of its present range except for northern New England and Nova Scotia, and to invade an area of boreal forest to the north. The question arises, however, whether changes in the podzolic soil of the boreal forest could occur fast enough to allow sugar maple to grow there. Another question is whether the four species are capable of migrating 500 km in 100 years or less; fossil records indicate range extensions for most tree species of only 10-40 km per century.

Increased dryness in many parts of North America

could cause additional stress on plants, but greater efficiency in water use can be expected because increased carbon dioxide levels cause plant stomates to close. Some plant species may be able to tolerate climatic change but die out through loss of ability to compete. Scots pine, for instance, ranged throughout the British Isles after the Pleistocene and now can be grown anywhere in the Isles horticulturally, but it can compete under natural conditions only in the north.

Animals, too, will be affected directly and indirectly by climate change. Direct effects should be pronounced on cold-blooded species, for instance, and on embryos of ground-nesting birds, as well as on species such as many turtles and geckos in which sex ratios are temperature-induced.

Animals may be affected indirectly by climate-induced changes in their food supply or their habitat. Migratory shorebirds, for instance, that feed on horseshoe crab eggs in spring in Delaware Bay, might not be able to adjust if climate change altered the timing of horseshoe crab reproduction. Slow migrators such as snails will be losers and fast migrators such as birds will be comparative winners, assuming species comprising their habitats and food can migrate rapidly as well – a large assumption.

Numerous changes in plant-animal interactions are expected. For instance, slug feeding on mint in redwood forests would decrease under drier conditions because the slug is moisture restricted whereas the mint is not. Pollination could be disrupted because of evaporation of volatile pheromone "markers" that tell insects which flowers have already been pollinated.

Much information needs to be collected and analyzed before a basic understanding can be arrived at about how human activities influence global climate, according to a briefing by six U.S. scientists for NASA officials in D.C. recently, but Robert E. Dickinson of the National Academy of Sciences told the administrators: "You should be prepared to [formulate policy] now, so that in 10 years when you do understand the problem, you can do something about it without having to wait another 10 years." *Science News*, Nov. 5, 1988, p. 293.

Soil organisms in general have wide tolerances for temperature and moisture conditions. Taxonomic groups are therefore similar worldwide. Climate change would probably affect soil organisms primarily through effects on vegetation and resulting changes in soil processes. Functional changes rather than much loss of species is expected.

There is bad news on the disease front: tropical parasites probably will invade warm temperate zones. The tsetse fly, for instance, would be displaced northward in Africa, subjecting large new areas to sleeping sickness and livestock mortality, while opening the former range to increased exploitation.

Exotic species are expected to profit everywhere, taking advantage of the widespread habitat disturbance and die-offs caused by climate change. It was suggested that this is not all bad: exotics might thus play a stabilizing role during the climatic transition. Furthermore, what is "exotic" might have to be redefined under a changing climate.

In the sea, said Carleton Ray of the University of

Virginia, the effects should be greatest in coastal and continental shelf waters, which are the most productive. The rich fisheries of temperate to boreal waters can be expected to decline, whereas coral reefs might expand poleward. Species loss may not be great because of typically wide ranges, reproductive capacities, and dispersal mechanisms.

Barrier island landward migration rates, now averaging 1.5 m per year on the U.S. east coast, could increase by 50-600 percent under a projected sea level rise of 10-100 cm in the next 50 years. Estuarine habitats for many marine species would almost assuredly be affected, Ray said. Larry Harris (University of Florida) pointed out that a one-foot rise – about 30 cm – would bring the sea 10 miles farther into the Everglades.

The effects of climate change were brought home most forcefully when specific regions were considered. Marine organisms of the Arctic Ocean would be profoundly affected if warming resulted in melting of sea ice. The food chain depends heavily on algae that grow on the bottom of sea ice and fall to the ocean floor, and on seasonal algal blooms in low salinity meltwaters. Furthermore, polar bears and other animals rely on sea ice for transportation.

Dwight Billings of Duke University foresaw drastic changes in the arctic tundra on Alaska's North Slope if global warming led to disturbance of the sedge-grass cover. "... the ecological effects could lead to loss of system integrity due to decomposition of peat and the loss of the upper permafrost. It is the upper permafrost that binds this ecosystem together as it has for at least the last 10,000 years. If the upper 2 to 3 meters of permafrost is lost, the wet coastal tundra is lost."

Boreal and Pacific Northwest forests would be transformed as well. Using the JABOWA model of forest growth, Daniel Botkin of UC-Santa Barbara projected replacement of the boreal forests of the Boundary Waters Canoe Area by northern hardwoods between the year 2010 and 2040. Jerry Franklin, assuming a 2-5°C temperature increase and little or no change in precipitation in the Pacific Northwest, predicted changes there due mainly to increased wildfire, storms, and pests and pathogens that would result from the drier conditions. Among the overall effects of these disturbances could be loss of diversity as species fail in "tracking" suitable habitat, and a shift from forest to nonforest cover, such as chaparral, because of failure of forest trees to reproduce on disturbed areas.

Less alteration was expected in the Mediterranean ecosystems of California/Baja California and in tropical rain forests. The predicted warmer and wetter climate for the California Floristic Province would result in greater evapotranspiratory stress. Expected vegetation responses are an expansion of chaparral at the expense of southern oak woodland, and an upward extension of pine and red fir forests in the Sierra Nevada. Thorn scrub, now in Mexico, might invade California for the first time since the Miocene.

Responses of humid tropical forest were inferred from observations of ecological change at a few neotropical sites. Global warming, per se, was not expected to have serious effects on tropical forest biodiversity, except near the latitudinal and altitudinal limits of these forests. But changes in the seasonality of rainfall could alter the species composition and population structure of communities, and could affect plant phenology, frequency of reproduction, and altitudinal migration, as well as susceptibility to natural disasters. The lack of a dry season,

Evaluating Recreation Impacts: A Multi-Faceted Research Design

By Jeffrey L. Marion and David N. Cole

Management goals for most National Park Service lands stress preserving natural conditions and avoiding conspicuous evidence of human use. Environmental impacts resulting from different types of recreational use compromise these goals to varying degrees. In the Mid-Atlantic Region, concern over resource impacts associated with expanding river recreation and camping activities led to the initiation, in 1985, of recreation impact research in three river oriented parks: Delaware Water Gap National Recreation Area, Upper Delaware Scenic and Recreational River, and New River Gorge National River.

Most recreational impact research consists of short-term, one-of-a-kind studies that do not build on one another. This is unfortunate because the recreation impact system is complex, with interacting and confounding variables. Most research designs have serious limitations and when a long-term perspective is lacking, results are frequently misleading. We tried to minimize these problems by designing a multi-faceted research project that would provide a more comprehensive picture of what impacts were occurring and how they might be monitored and managed. This paper describes the range of studies we designed in the hope that this might serve as a model for studies with similar objectives.

Research Objectives

The primary goals of our research program were (1) to characterize the nature of site impacts resulting from recreational use and (2) to assess how the number and type of recreational users and the characteristics of the sites they use influence these impacts. Many techniques for managing recreational impacts exist, but the most appropriate and effective techniques for managing particular situations are not always obvious. Management programs aimed at minimizing such impacts require

answers to a number of questions. What types of impacts are occurring and what is their current severity and distribution? How and to what extent are impacts related to environmental factors such as vegetation, soil, and landform types? How and to what extent are impacts related to different types and amounts of use? How and to what extent are impacts changing over time?

Research Approach and Methodology

After assessing the advantages, disadvantages and implicit assumptions of various research approaches, the following set of studies was selected:

1. *Cross-Sectional Descriptive Survey of Recreation Sites and Adjacent Control Sites* – A series of measurements, including assessments of recreation site area, revegetated core area, tree damage, tree reproduction, vegetative ground cover, vegetative composition, soil loss, soil compaction, and soil moisture, were taken on 55 recreation sites in the three parks. Similar measurements were taken on neighboring undisturbed sites (controls) with similar environmental settings. Differences between recreation sites and controls provide an estimate of how much impact has occurred as a result of recreational use. We compared amount of impact on sites with different amounts of use, types of users and in different environmental settings, to determine the importance of these independent variables.

2. *Longitudinal Study of Change Over Time on Long-Established Sites* – The descriptive survey was based on measurements that could be precisely replicated at a future date. This will allow us to repeat measurements in five years and determine how these sites – again stratified by amount and type of use and environment – are changing over time.

3. *Longitudinal Study of Change Following Site Creation* – Site conditions were measured on several

new sites prior to and at periodic intervals after they were opened for use. Measurements were similar to those in the descriptive survey. Changes were also monitored on control sites in order to incorporate changes not related to recreational use into the final interpretation of results. This study will be continued for at least three years. This approach provides more accurate assessments of recreational impact than the descriptive survey because it eliminates errors associated with the assumption that a site was originally identical to a control. The problems with this approach are that results are not available for several years and it can be difficult to locate new sites that are typical of user-created campsites.

4. *Longitudinal Study of Change Following Site Closure* – Site conditions were measured on several sites prior to and at periodic intervals after they were closed to use. As above, measurements were similar to those in the descriptive survey, changes were also monitored on control sites, and the study will be continued for at least three years.

5. *Experimental Trampling Study in Different Environments* – Experimental trampling, within a factorial research design, was used to evaluate the relationships between trampling impacts to vegetation and soil and (a) amount of trampling, and (b) vegetation type. Two different vegetation types, a grassland and a forest with an understory of forbs, were trampled at intensities of between 5 and 1000 passes per year. Trampling treatments and all vegetation and soil measurements will be repeated each year for at least three years in order to predict the long-term consequences of continued use. Experiments provide the best opportunity to control amount of use and to minimize differences in environment and type of use that tend to confound results. The major drawback is that experimental trampling does not truly simulate recreational activities.

In a related study, we are developing impact assessment and monitoring systems for the parks. Research included the following:

1. Impact assessment procedures developed elsewhere were evaluated in terms of their management efficiency, precision, and accuracy. The procedures judged to have the most promise were then modified to fit the conditions at Delaware Water Gap and New River Gorge. Monitoring programs are now in place at each of these parks.

2. Microcomputer software was modified to facilitate the entry and analysis of impact monitoring data. Extensive menu-driven programming, within the dBASE III package, has enhanced our ability to analyze the impact monitoring data bases at Delaware Water Gap and New River Gorge.

Results

Results of the descriptive survey are already available. We found, in general, that the nature and magnitude of impacts in these eastern riparian forests were quite similar to those reported in wilderness areas in the western United States and northern Minnesota, despite more favorable growing conditions. This suggests that the effectiveness of basic strategies for managing impact – such as visitor dispersal, visitor containment, visitor education or site management – should not differ greatly between regions.

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Greenhouse Effect

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for instance, could inhibit flowering of keystone fruit trees, leading to famine among frugivores.

How can we lessen the loss of biodiversity that seems imminent? First, improve knowledge, emphasizing processes rather than species. More refined models of climate change are an obvious requirement. Much interdisciplinary research is needed, and institutional adjustments and professional rewards to encourage this now unpopular activity. We need to expand development of integrated models, and increase long-term research. Boyd Evison stressed the need for basic data about current conditions, so biological effects of climate change can be better detected.

More active management of natural communities will also be required. "We will have to become ecological engineers of the first order," said Jerry Franklin. What this would entail was not the focus of this conference, but someone facetiously suggested moving trees rather than MX missiles northward on railroad flatcars. More seriously, Margaret Davis urged research on procedures necessary to artificially recreate natural forest communities in new locations farther north. Forest management should be directed toward reducing fragmentation and providing a landscape matrix that nurtures biological diversity. Such a landscape would be more

resilient to climate change and would ease the passage of migrating species. Natural reserves, it was stated, should be very large to minimize effects of random disturbance.

Besides seeking management mitigation practices, the underlying economic and political bases of the problem must be attacked. Congresswoman Claudine Schneider eloquently addressed this side of the issue while describing a bill she recently introduced to reduce emissions of greenhouse gases. She concluded by urging scientists to become lobbyists. "You must not sit by the sick bed," she said.

I found this conference extremely informative. It told us in some detail about the kinds of biological responses to expect. Future conferences no doubt will address the next questions: how species migrate, how we can assist in that process, and how we can maintain biological diversity until the long-term problem of atmospheric pollution is resolved. Papers from this conference will be published by Yale University Press in late 1989. If you wish to obtain them contact Stacey Roberts, Conference Coordinator, World Wildlife Fund-U.S., 1250 - 24th Street NW, Washington, D.C. 20037. Phone: (202) 778-9572.

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Instead it is the details of intensive management that will differ between regions and from area to area. How much use can occur before thresholds of acceptable change are exceeded? And how do these thresholds vary between environments or with type of use? How effective is site rehabilitation likely to be and how can rehabilitation be assisted?

We expect that further analysis of results from these studies will provide a more detailed understanding of the complex relationships between recreational use and resultant ecological changes in these parks. Direct management implications include, but are not limited to, identification of use thresholds for varied ecosystem types, improved campsite selection and design criteria, improved site management and rehabilitation techniques, improved minimum impact education messages, and evaluation and recommendation of appropriate management practices.

Finally, the development of efficient impact monitoring programs will enable resource managers to: (1) develop a quantitative data base documenting long-term changes resulting from recreational use, (2) detect and evaluate deteriorating and improving conditions, (3) analyze relationships between specific impacts and environmental features or use-related information, (4) evaluate the effectiveness of resource protection measures, and (5) set and monitor limits of acceptable change for resource conditions.

Readers interested in further information can request any or all of several reports from the senior author. These include a detailed study plan for the research program, Mid-Atlantic Region Research/Resources Management Reports on results of the descriptive surveys (one for each of the three parks) and the impact monitoring program at Delaware Water Gap; an article in *Environmental Management* on results of the descriptive survey; and a number of papers on monitoring methods.

Marion is a Research Biologist with the Mid-Atlantic Region; Cole is a Research Ecologist with the USFS Wilderness Research Unit.

Interpretation

**Virgin Islands Birdlife
Joint NPS/UVI Publication**

"Keep a green tree in your heart and perhaps the singing bird will come."

With this Chinese proverb, *Virgin Islands Birdlife*, by Roland H. Wauer, opens a book on the avian world of these Caribbean islands.

The 35-page, illustrated booklet describes the five bird communities of the Virgin Islands – ocean/bay, wetland, dry forest, moist forest, and developed areas. The most common birds are discussed first, followed by a chapter on enjoying and identifying, and another on protecting, wild birds. A section on "The Virgin Islands Connection" considers the importance of these "wintering grounds" for many of the U.S. migratory birds, especially the warblers. The appendices include a glossary of V.I. bird names, a checklist, and useful references.

The book breaks new ground in collaboration between the University of the Virgin Islands and NPS. Wauer is an NPS research scientist stationed in the Virgin Islands.

NPS and the Law

The National Parks and Conservation Association's newest publication, *Our Common Lands: Defending the National Parks*, is a compilation of 18 essays by some of America's most noted legal scholars, examining the current state of park protection law in the United States. From the NPS Organic Act to the Clean Air Act, the book describes where American environmental law has been both effective and ineffective in protecting national parks.

Former Interior Secretary Stewart L. Udall has described the book as "First rate ... invaluable. This superb book contains all the elements of a battle plan to preserve the national parks."

The book will be reviewed in the Spring issue of *Park Science* by Ray Herrmann, Chief of the Water Resources Division's Branch of Applied Research.